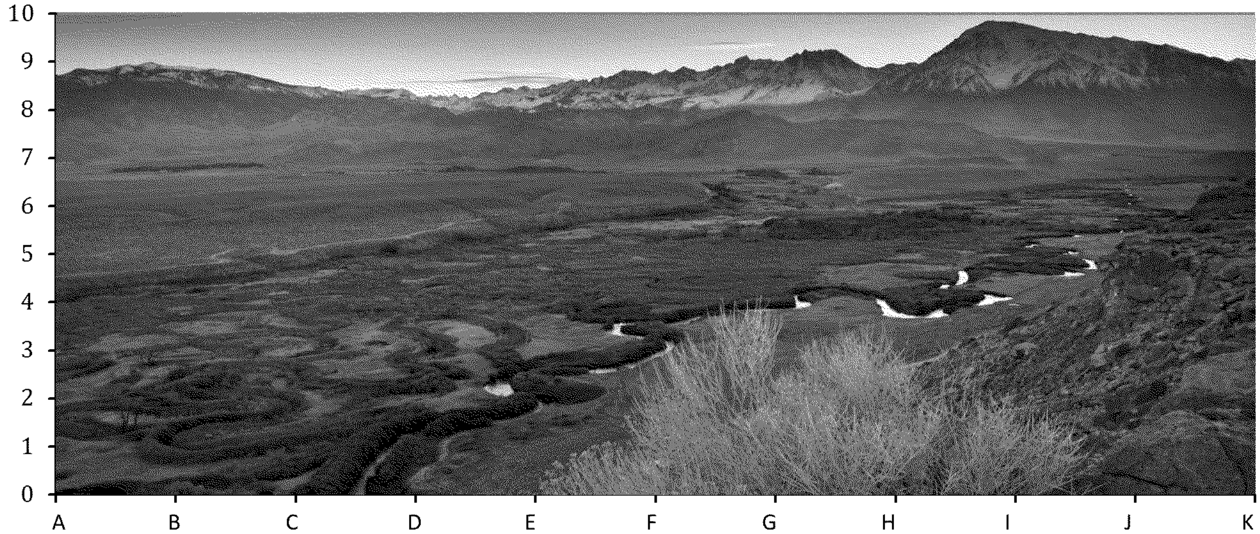
Technical Memorandum

California Wetland Monitoring Workgroup



Framework to Coordinate Water Quality Improvement and Wildlife Habitat Conservation to Protect California Streams, Wetlands and Riparian Areas

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Prepared by the San Francisco Estuary Institute and Aquatic Science Center
on behalf of the California Wetlands Monitoring Workgroup

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Framework to Coordinate Water Quality Improvement and Wildlife Habitat Conservation

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Acronyms

3DEP: 3D Elevation Program

ACE-II: Areas of Conservation Emphasis Viewer

BASMAA: Bay Area Stormwater Management Agencies Association

BIOS: Biological Information and Observation System

CALVEG: California Vegetation Mapping Program

CARI: California Aquatic Resources Inventory

CCCFCWCD: Contra Costa County Flood Control and Water Conservation District

CCCRCD: Contra Costa County Resource Conservation District

CCCWD: Contra Costa County Water District

CCCWP: Contra Costa Clean Water Program

CDFG: California Department of Fish and Game (precedes CDFW)

CDFW: California Department of Fish and Wildlife

CDPR: California Department of Parks and Recreation

CDWR: California Department of Water Resources

CEDEN: California Environmental Exchange Network

CEQA: California Environmental Quality Act

CNDDB: California Natural Diversity Database

CNRA: California Natural Resources Agency

CO-OPS: Center for Operational Oceanographic Products and Services

CRAM: California Rapid assessment Method

CSCI: California Stream Condition Index

CWA: United States Clean Water Act

CWHR: California Wildlife Habitat Relationships

CWMW: California Wetland Monitoring Workgroup

DEM: Digital Elevation Map

EBRPD: East Bay Regional park District

ECCC: East Contra Costa County

ECCCHC: East Contra Costa County Habitat Conservancy

EIP: Tahoe Environmental Improvement Program

ESA: United States Endangered Species Act

FGDC: Federal Geographic Data Commission

FSA: Federal Service Agency

Acronyms (continued)

GSD: Ground Sample Distance

HCP: Habitat Conservation Plan

IFP: Instream Flow Program

LRWQCB: Lahontan Regional Water Quality Control Board

MeHg: Methylmercury

MRP: Municipal Regional Permit of the SWRCB or an RB

NAIP: National Agricultural Imagery Program

NCCP: Natural Community Conservation Plan

NCCPA: Natural Community Conservation Planning Act

NED: National Elevation Dataset

NHD: National Hydrographic Dataset

NLCD: National land Cover Database

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

NRC: National Research Council

NRCS: Natural Resources Conservation Service

NWI: National Wetlands Inventory

NWLON: National Water Level Observation Network

PCB: Polychlorinated Hydrocarbon

PFC: Proper Functioning Condition

PFC: Proper Functioning Condition

PRISM: Parameter elevation Regression on Independent Slopes Model

QAQC: Quality Control and Quality Assurance

RAMP: Regional Advanced Mitigation Plan

RB: Regional Water Quality Control Board or Regional Board of the SWRCB

RGP: Regional General Permit of the USACE

RIBITS: Regulatory In Lieu fee and Bank Information Tracking System

RipZET: Riparian Zone Estimator Tool

SAMP: Special Area Management Plan

SANDAG: San Diego Association of Governments

SOP: Standard Operation Procedure

Acronyms (continued)

SWAMP: California Surface Water Ambient Monitoring Program

SWRCB: California State Water Resource Control Board or State water Board

TAT: Technical Advisory Team of the State Wetland and Riparian Area Protect Policy

TNC: The Nature Conservancy

TRPA: Tahoe Regional Planning Agency

URL: Uniform Resource Locator

USACE: United States Army Corps of Engineers

USDA: United States Department of Agriculture

USEPA: United States Environmental Protection Agency

USFS: United States Forest Service

USFWS: United States Fish and Wildlife Service

USGS: United States Geological Survey

USNVC: United States National Vegetation Classification Standard

Veg CAMP: California Vegetation Classification and Mapping Program

WBD: Watershed Boundary Dataset

WDR: Waste Discharge Requirement

WRAMP: Wetland and Riparian Area Monitoring Plan

WRAMPw: Wetland and Riparian Area Monitoring Plan for wildlife

WSS: Web Soil Survey

Framework to Coordinate Water Quality Improvement and Wildlife Habitat Conservation

Executive Summary

Overview

The emergence of comparable landscape approaches to wildlife conservation and water quality improvement through federal and California state regulatory and management programs provides an opportunity for their coordination to enhance the protection of California's aquatic resources, especially streams, wetlands, and riparian areas. Such coordination is patently desirable.

A framework has been developed to help coordinate restoration and compensatory mitigation across policies governing wildlife conservation and water quality in the landscape context. The framework is based on the Wetland and Riparian Area Monitoring Plan (WRAMP)[1] of the California Wetland Monitoring Workgroup (CWMW) of the Water Quality Monitoring Council. The framework presented here is a version of the standard WRAMP framework. It only differs from the standard framework to better accommodate wildlife conservation planning, assessment and reporting. To distinguish this version from the standard version, it is termed the WRAMP for wildlife (WRAMPw).

Untold millions in state and federal tax dollars have been spent through many public agencies over the last two decades to develop the monitoring tools featured here. Before more public monies are spent to develop new tools of these kinds, the WRAMPw framework should be used to bring together the existing tools into a coherent toolset. This memorandum explores how the existing tools can be used in a coordinated way to improve both water quality and wildlife conservation.

WRAMPw is currently focused on increasing the combined effectiveness of the Dredge and Fill policies of the USACE, USEPA, and State Water Board (Sections 404 and 401 programs of the U.S. Clean water Act, and the Waste Discharge Requirements Program of the State Water Board), and federal and state habitat conservation planning (Habitat Conservation Plans of the USFWS and Natural Community Conservation Plans of the CDFW). In the future, the framework can be applied in local watersheds to help coordinate wildlife conservation and water quality improvement with flood control, stormwater management, irrigation, and other local aquatic resource management programs.

WRAMPw brings together the entire process of cost-effective environmental monitoring and assessment into one coherent 10-step procedure based on the foundational tenets of adaptive management. In a sentence, the framework couples monitoring and assessment to specific information needs of aquatic resource regulators and managers through the standardized use of common monitoring approaches and tools. The ten steps of the WRAMPw framework are as follows:

1. Identify the concerns driving new habitat conservation or water quality improvement actions;
2. Develop or apply conceptual models to translate the driving concerns into monitoring questions;
3. Develop the monitoring goals and objectives;
4. Further develop or reapply the conceptual models to prioritize data needs;
5. Formulate the monitoring metrics and data collection plan;
6. Explore the relative benefits of alternative actions in the landscape context;
7. Identify the preferred actions;
8. Conduct the monitoring and assessment;
9. Interpret and report the monitoring results; and
10. Revisit and, if necessary, revise the driving concerns and management questions.

[1] http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/#frame

A central concept of both the standard WRAMP framework and WRAMPw is the landscape profile. A landscape profile is the abundance, diversity, distribution, and condition of aquatic resources in a given landscape. The preferred profile quantifies an envisioned future landscape that is expected to provide acceptable levels water quality and wildlife support. For any given landscape, the various agencies and programs responsible for aquatic resource protection would ideally adopt the same preferred landscape profile as their common overall goal.

The primary tools and data sources that can serve coordinated monitoring and assessment have been organized according to the WRAMPw framework. The primary tools that fit the framework and that can be applied in a standardized way across the state are summarized in the following recommendations. The tools and data sources referenced in these recommendations are explained in the memorandum.

Some adaptation of these tools will be necessary to assure that they work well together. Despite this upfront cost, the coordinated use of these tools could significantly increase the value of funded actions to improve water quality and conserve wildlife by increasing their effectiveness while reducing costs for tool upkeep, data management, and public reporting.

Recommendations

For any landscape-based plan to monitor and assess aquatic resources, the following actions are recommended. Each represents an intended output of one or more steps of the WRAMPw framework. The closing recommendation addresses the need to manage further development of WRAMPw and its future applications.

Identify the driving concerns and translate them into monitoring questions.

As with most other environmental monitoring frameworks, the WRAMPw framework requires that all monitoring and assessment must stem from clearly stated regulatory or management concerns that can be translated into monitoring questions and data needs. No data should be collected that do not address the driving concerns as directly as possible.

Set goals and objectives.

Develop conceptual models to translate driving concerns into landscape-specific goals and objectives for wildlife conservation and water quality improvement. The goals and objectives must be compatible with each other and with applicable, existing goals and objectives. Existing goals and objectives may need to be revised. The policies and programs to conserve wildlife and improve water quality should align behind the new and revised landscape management goals and objectives.

Get a map.

A base map of surface water, vegetation, and topography that commonly serves all water quality and wildlife conservation actions is the single most important technical tool for their coordination. The key data sources for a suitable base map are:

- California Aquatic Resource Inventory (CARI) of CWMW;
- National Wetlands Inventory (NWI) of USFWS;
- National Hydrographic Dataset (NHD) of USGS;
- The 3D Elevation Program of USGS;
- CALVEG of USFS;
- California Vegetation Classification and Mapping Program (VegCAMP) of CDFW.

Custom data can be used if they meet the standards of the statewide datasets listed above. Of these datasets, CARI is perhaps the most important. CARI consists of the best available maps of surface waters but may not be adequately detailed or accurate for some locations and uses. Efforts to revise CARI should apply the CARI SOP through the CARI online editor tool, such that the revisions can be incorporated into the statewide basemap for the EcoAtlas information delivery system. Any custom vegetation data must have a crosswalk to the CWHR. LiDAR may be used to produce a digital elevation map (DEM) based on the CARI SOP.

Determine what to measure.

Develop conceptual models of how the landscape works as a physical system. The models should identify known or expected casual relationships and the relative roles of natural processes and human operations on water quality and the landscape profile. The assumptions and uncertainties of the model should be explained. The uses of establish fact, statistical extrapolations from fact, and expert guesswork should be documented. Based on the goals and objectives and these models, identify habitat types and water quality parameters that should be monitored.

The monitoring program should focus on conditions rather than their causes. Special studies may be needed to test hypothesized causes for inadequate performance of management or regulatory actions, as indicated by the monitoring data. Monitoring is needed to reveal conditions, whereas research is needed to explain conditions.

Develop key map layers.

Convert the vegetation layer of the base map into a map of terrestrial wildlife habitat using the crosswalk between the vegetation classification system and CWHR. Similarly, use the crosswalk between CWHR and the classification systems of CARI and RipZET to create a map layer of aquatic and riparian habitat.

Develop additional data layers necessary to characterize the landscape relative to the goals and objectives for its management. These layers might include land cover, roads and other infrastructure, soils, rainfall, wildlife conservation actions, and water quality improvement actions.

Envision the Ideal future landscape.

Use the base map and key map layers in a Geographic Information System (GIS) to compare alternative future landscapes in terms of their abilities to meet the goals and objectives for wildlife conservation and water quality improvement. The optimal alternative landscape will have a preferred profile. Within California, the most suitable tools for landscape scenario planning are:

- Landscape Profile Tool and EcoAtlas of CWMW;
- Spatial Pattern Analysis Program for Categorical Maps (FRAGSTATS) of UM at Amherst;
- MARXAN of UC at Davis;
- Areas of Conservation Emphasis Viewer (ACES-II) of CDFW;
- Biogeographic Information and Observation System (BIOS) of CDFW.

Landscape scenario planning is a growing interest for many environmental planning and management programs. The availability of dense spatial data sets to characterize landscapes, plus the speed at which complex spatial relationships can be resolved and visualized is increasing the practicality of comparing realistic alternative future landscapes with regard to multiple management objectives. It is therefore likely that the tools available today will be elaborated in the near future.

Track actions.

Use Project Tracker in EcoAtlas with web service links to HabiTrak and RIBITS to create a comprehensive map of habitat creation, restoration, and enhancement projects, habitat acquisitions, data collection sites, and other on-the-ground actions as overlays on the base map. The map of actions should consist of polygons of each distinct action including each separate site of multi-site projects or monitoring efforts. Each polygon should serve as an interactive repository for site-specific data and information that can be shared through Project Tracker, summarized across landscapes using the Landscape Profile Tool, and visualized in EcoAtlas.

Monitor and assess conditions.

Monitoring data are not useful unless they address the driving concerns as directly as feasible. Many of the same tools can be used to assess compliance for individual on-the ground actions, including land acquisitions and easements, as well as their cumulative effects across a landscape.

To control data costs, the process to identify needed data should begin with careful consideration of the least expensive data types and methods of data collection for the aspects of wildlife or its habitat and water quality parameters that must be monitored. To assist in data selection, the WRAMPw framework includes a 3-level system to classify monitoring tools and data based on their dependence on quantitative field or laboratory work, which generally reflects their relative costs.

Level 1 data are derived from maps and remotely sensed imagery. In addition to the data used to build the base map, the following Level 1 data and tools are generally useful:

- Web Soil Survey of USDA;
- Parameter elevation Regression on Independent Slopes Model (PRISM) of USDA;
- California Natural Diversity Database (CNDDB)of CDFW;
- National Land Cover Database (NLCD) of USGS;
- National Agricultural Imagery Program (NAIP) of USDA;
- Riparian Zone Estimator Tool (RipZET) of CWMW;
- CALVEG of USFS;
- California Vegetation Classification and Mapping Program(VegCAMP) of CDFW;
- California Wildlife Habitat Relationships (CWHR) of CDFW.

Level 2 data are generated by rapid methods of field assessment that typically require less than a day to apply and that do not rely on the collection of field materials or any laboratory analysis. The most popular Level 2 methods in California are:

- Proper Functioning Condition (PFC) of BLM and the USFS;
- California Rapid Assessment Method for wetlands and streams (CRAM) of CWMW.

Level 3 data quantify one or more aspects of aquatic resource condition or stress, relative to other aspects or per unit time or space, based on field measurements. The Surface Water Ambient Monitoring Program (SWAMP) of the State Water Board oversees many Level 3 methods relating to water quality. In addition, some key statewide Level 3 methods and data sources for characterizing California aquatic wildlife habitats are listed below:

- USGS and CDFW Steam Gauging;
- NOAA Tide Gauging;

- USFS Stream channel reference site SOP;
- State Water Board Depressional Wetlands Macroinvertebrate SOP;
- State Water Board California Stream Condition Index (CSCI).

Assess the effectiveness of the landscape plan and associated policies and programs based on landscape ecology metrics, such as the abundance, diversity, patch size-frequency, and connectivity of key habitat types, using the base map and selected additional map layers. Use these same map layers to develop probabilistic sample frames for ambient assessments using the same Level 2 and Level 3 methods that are also used to assess project performance. Using the same methods to assess projects and ambient condition increases the ability to assess project effectiveness in the landscape context. All data must elucidate the condition of the landscape and individual projects relative to the management goals, objectives, and other performance criteria.

Report condition.

A major intent of the framework is to guide monitoring and assessment of aquatic resources from clear data needs to clear public reporting of what the data mean. The reports depend on ready access to data management and delivery systems. The primary statewide systems for managing or viewing data and information about natural aquatic resources are listed below:

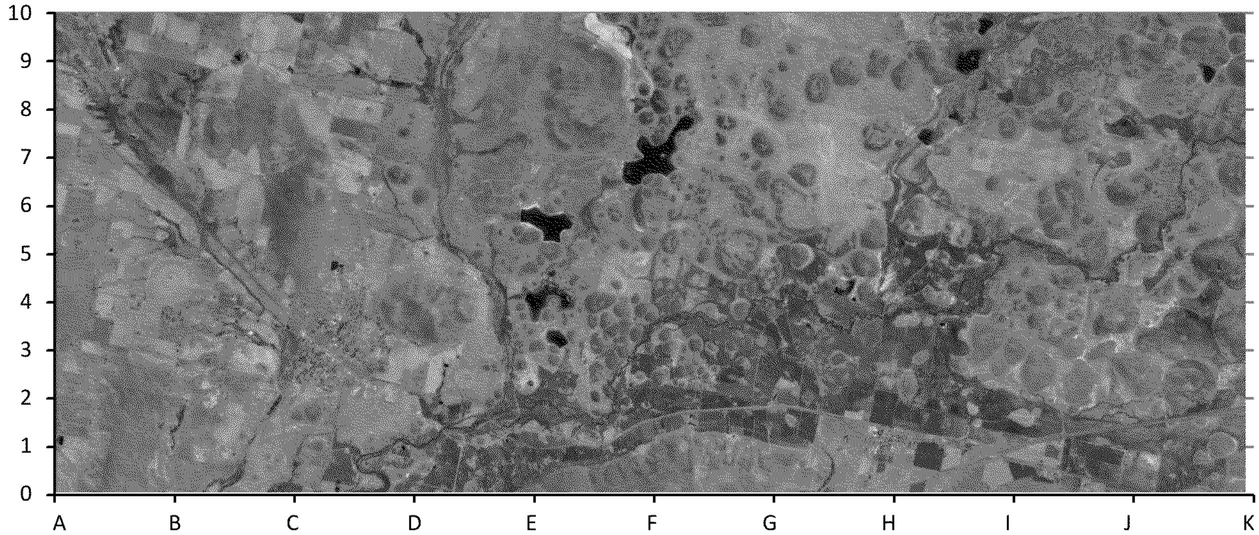
- California Environmental Data Exchange Network (CEDEN) of the State Water Board;
- HabiTrak of San Diego County;
- Project Tracker of CWMW;
- Landscape Profile Tool of CWMW;
- California EcoAtlas of CWMW;
- Areas of Conservation Emphasis Viewer (ACE-II) of CDFW;
- Biogeographic Information and Observation System (BIOS) of CDFW
- Regulatory In-Lieu Fee and Bank Information Tracking System (RIBITS) of USACE.

According to the WRAMPw framework, coordinated landscape approaches to wildlife conservation and water quality improvement should generate consistent landscape health reports that feature Health Report Cards. The report card is a simple graph of landscape condition as percent attainment of the goals and objectives for water quality and wildlife conservation. Condition can be reported for any set of projects, wildlife species, habitat types, or water quality parameters, and can therefore be used to assess the performance of projects, program, and policies.

Use the CWMW as the WRAMPw steering committee.

Implementation of the WRAMPw framework will require coordination among the federal and state agencies most responsible for protecting California wetlands, streams, and riparian areas. It will also require coordination across regional and local policies and programs affecting these resources within individual watersheds and other landscapes.

The CWMW is responsible for developing the WRAMP framework and its toolset. The CWMW is the most suitable, existing, interagency forum for overseeing all versions of WRAMP, including the WRAMPw. However, more representation of state and federal programs for wildlife science and conservation is needed on the CWMW. The leaders of the CWMW should therefore use this technical memorandum to reach out to these programs for their greater involvement in the CWMW.



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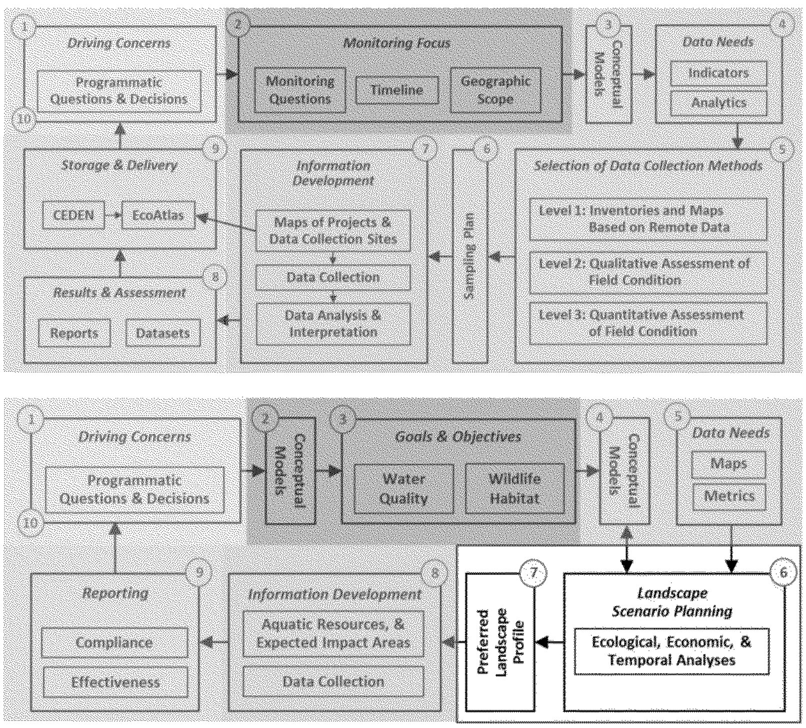
Framework to Coordinate Water Quality Improvement and Wildlife Habitat Conservation

Introduction

A framework has been developed to help coordinate restoration and compensatory mitigation actions across policies governing wildlife conservation and water quality through California. The framework is based on the Wetland and Riparian Area Monitoring Plan (WRAMP)[2] of the California Wetland Monitoring Workgroup (CWMW) of the Water Quality Monitoring Council. The framework presented here is a version of the standard WRAMP framework (Figure 1). It only differs from the standard framework to highlight aspects relating especially to wildlife conservation planning, assessment and reporting. To distinguish this version from the standard version, it is, for the purpose of this document, termed the WRAMP for wildlife or WRAMPw.

Figure 1: Correspondence between (A) the Standard WRAMP framework and (B) the version adapted for wildlife conservation (WRAMPw). Corresponding steps are like-colored. WRAMPw is distinguished by Landscape Scenario Planning and the development of a Preferred Landscape Profile (steps outlined in red). Each aspect of the WRAMPw framework is explained elsewhere in this report.



This framework is based on three assumptions. First, improving the ability of landscapes to retain and filter precipitation and runoff through natural features and processes generally benefits water quality. This assumption underlies the watershed or landscape approach to water quality improvement (USEPA 1996, Thomas and Lamb 2005, USACE and USEPA 2008, Hruby et al. 2009, Sumner et al. 2010). Second, water retention and filtration can be improved across landscapes by increasing the quantity, quality, and resilience of aquatic and semi-aquatic habitat types, including floodplains, wetlands, and riparian areas (TAT 2009, ELI and TNC 2014). Third, these habitat improvements can benefit wildlife.

This framework is focused on streams, wetlands, and riparian areas.[3] The focus on these resources is justified by their importance as landscape features. Wetlands remain the most abundant form of inland surface waters in California,[4] despite a 90-95% historical reduction in their acreage (Frayer et al. 1989, USDI 1994, Dahl and Allord 1996). Because of their significant ecological and economic values, wetlands and streams are protected by an array of

[2] http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/#frame
[3] WRAMPw pertains to these habitat types as defined by any state or federal agency.
[4] Based on the California Aquatic Resources Inventory (http://www.sfei.org/cari).

federal and state statutes. Riparian areas serve to buffer wetlands and streams while providing their own benefits to water quality and wildlife (Naiman Et al. 2000, NRC 2002).

This framework can help coordinate aquatic resource planning, monitoring, and assessment for wildlife conservation and water quality improvement. Such coordination can involve many public policies and programs (Kusler 1983, Fretwell et al. 1996, ELI 2008), and should be conducted in a landscape or watershed context (USEPA 1996, ELI and TNC 2014). There are five federal and state regulatory programs most directly affecting wetland, stream, and riparian protection in California. These are:

- Dredge and Fill program of section (404 program) of section 404 the U.S. Clean Water Act (CWA) administered by the U.S. Army Corps of Engineer (USACE) and U.S. Environmental Protection Agency (USEPA)[5];
- Habitat Conservation Planning program (HCP) of the U.S. Endangered Species Act (ESA) administered by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)[6];
- Natural Community Conservation Planning program (NCCP) of the Natural Community Conservation Planning Act (NCCPA) administered by the California Department of Fish and Wildlife (CDFW)[7].
- 401 Certification Program (401 Program) of the CWA administered by the California State Water Resources Control Board (SWRCB)[8]; and
- Waste Discharge Requirements program (WDR) of the Porter-Cologne Water Quality Control Act (Porter-Cologne) administered by the SWRCB.[9]

The SWRCB generally refers to its 401 Program and WDR together as the 401-WDR Program. There are many other federal, state, and local laws and programs affecting aquatic resources, including the Lake and Streambed Alteration Program of the CDFW,[10] but the five regulatory programs listed above are most directly responsible for protecting California's streams, wetlands, and riparian areas.

A large-scale HCP or NCCP is essentially a landscape approach to compensatory mitigation for legal impacts to wildlife under ESA and NCCPA. The Mitigation Rule (USACE and USEPA 2008), the Regional Compensatory Mitigation and Monitoring Guidelines of the USACE (USACE 2013),[11] and the State Water Board's Water Quality Control Policy for Wetland Area Protection and Dredged or Fill Permitting (SWRCB 2013)[12] call for a similar approach to compensatory mitigation for legal impacts to water quality under CWA and Porter Cologne.

The emergence of similar landscape approaches to wildlife conservation and water quality improvement through federal and California state regulatory and management programs provides an opportunity for their coordination to enhance the protection of California's aquatic resources, especially streams, wetlands, and riparian areas.

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[5] http://www.epa.gov/cwa-404/section-404-permit-program.
[6] http://www.fws.gov/endangered/what-we-do/hcp-overview.html.
[7] https://www.wildlife.ca.gov/Conservation/Planning/NCCP.
[8] http://www.waterboards.ca.gov/water_issues/programs/cwa401/
[9] http://www.waterboards.ca.gov/water_issues/programs/land_disposal/waste_discharge_requirements.shtml
[10] https://www.wildlife.ca.gov/conservation/LSA
[11] http://www.spa.usace.army.mil/Portals/16/docs/civilworks/regulatory/Mitigation/MMG%20March%2012%202015%20presentation.pdf.
[12] http://www.waterboards.ca.gov/water_issues/programs/cwa401/docs/wrapp/policy_draft.pdf

The Wetland and Riparian Area Monitoring Plan (WRAMP)[13] can help achieve this coordination because it is designed to support coordinated, multiagency, landscape-based wetlands planning, regulation, and management. It includes tools that can be implemented through federal, state and local programs to assess aquatic resources, plan and track on-the-ground actions affecting the resources, and summarize conditions and actions across landscapes. One increasingly important purpose of environmental monitoring is to support adaptive management (Allen et al. 2001, Atkinson et al. 2004, Holling 2005), and is this framework entirely consistent with the basic tenets of adaptive management (Stankey et al. 2005, Nichols and Williams. 2006, McFadden et al. 2011, Williams 2011, Rist et al. 2013).

Neither WRAMP nor the WRAMPw has been adopted broadly enough in California to realize its potential. It's being incorporated into the 404 Program of USACE and USEPA and the 401-WDR Program of SWRCB. It's also being incorporated into wetland restoration programs of the Central Valley and Bay Area Habitat Joint Ventures, Tahoe Regional Planning Agency, Tahoe Conservancy, Sacramento-San Joaquin Delta Conservancy, and the State Coastal Conservancy. However, THIS FRAMEWORK has yet to be incorporated into large-scale HCPs of the USFWS, or NCCPs of CDFW.

Applications of this framework to large-scale HCPs and NCCPs as well as the 404 and 401 programs could significantly benefit wildlife conservation as well as water quality improvement. More than one-third of the state's threatened and endangered species live only in wetlands,[14] and most wildlife benefit from wetlands to some degree. The support of wildlife is a formally recognized benefit of water quality control, as represented by multiple Beneficial Uses of the California State Water Code.[15]

Key Definitions

What are wetlands?

There are generally two sets of wetland definitions used in California. One set applies to mapping wetland resources for assessment and management purposes. Another set of definitions applies to the identification and delineation of wetlands on the ground for legal, regulatory purposes.

The definitions used for mapping consist of standardized remote sensing methods to identify and delimit wetlands based on location and the visual or spectral signatures of surfaces waters and wetland vegetation (Tiner 1996, Klemas 2011, Lang et al. 2015). The primary programs for wetland mapping in California are the National Wetlands Inventory (NWI) of USFWS[16], the National Hydrographic Dataset (NHD) of USGS[17], and the California Aquatic Resource Inventory (CARI)[18] of the California Wetland Monitoring Workgroup (CWMW). CARI includes the standardized operating procedures for the proposed statewide California Aquatic Resources Status and Trends Program.[19] Each of these programs involves a different wetland classification system. However, crosswalks between the systems have been developed. For the purposes of wetland planning and management, HCPs and NCCPs tend to rely on NWI (FGDC 2013), NHD, and CARI, or they develop their own unique mapping methods and classification systems.

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[13] http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/#frame.
[14] Based on review of species lists and profiles for California (https://www.dfg.ca.gov/wildlife/nongame/t_e_spp/).
[15] The beneficial uses of California state waters include fish and wildlife preservation and enhancement (http://www.swrcb.ca.gov/waterrights/water_issues/programs/public_trust_resources/#beneficial).
[16] http://www.fws.gov/wetlands/NWI/Index.html.
[17] http://nhd.usgs.gov/.
[18] http://www.sfei.org/cari.
[19] http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/833_AquaticResourcesStatusAndTrends.pdf

The definitions used for regulatory purposes involve one or more of three environmental wetland parameters: hydrology, soils or substrate, and vegetation (Tiner 1996). The definitions are applied in the field using standardized indicators of the parameters to identify and delineate jurisdictional wetlands. The federal and state agencies most responsible for water quality control in California, namely USACE, USEPA, and the State Water Board, use the three-parameters approach to delineate wetlands[20], although the State Water Board has proposed a definition that excludes vegetation when it is naturally absent (SWRCB 2009). Other California state agencies rely on fewer parameters to legally define wetlands (e.g., CCC 2011, CNRA 2007). Different agencies use different systems to classify jurisdictional wetlands. Federal agencies tend to use the NWI system (FGDC 2013), although the hydrogeomorphic classification system (i.e., Brinson 1993, NRCS 2013) has been used by the USACE and the NRCS in some regions of the state.

What are streams?

Different agencies responsible for stream management and protection in California have adopted different stream definitions for their particular programs. For the purposes of this framework, the stream definition being proposed for the 401-WDR Program of the State Water Board seems most appropriate. That is: a stream is a physically defined course of perennial or episodic-water flow inclusive of physical, chemical, and biological processes and conditions resulting from recurrent interactions among the flow, subsurface water, and the adjacent landscape.

It is important to note this definition pertains to extant streams, which are features that currently function as streams and that are expected to function as streams in the future. Features of extinct streams, such as remnant channels and levees that individually or in aggregate do not meet the steam definition criteria are not considered to be streams.

What are riparian areas?

The State Water Board has tentatively adopted a definition of riparian areas that is based on the definition developed by the National Research Council (NRC 2002), with one essential clarification... The proposed State Water Board definition specifies that all aquatic areas, including wetlands, have riparian areas. While this is implied by the NRC definition, it is explicitly stated by the proposed State Water Board definition: Riparian Areas are areas through which surface and subsurface hydrology and other physical and biological processes interconnect aquatic areas and their adjacent landscapes; they are distinguished by gradients in biophysical conditions, ecological processes, and biota and they can include aquatic areas, wetlands, and portions of uplands that significantly influence the conditions or processes of aquatic areas.

According to this definition, riparian areas are not defined by plant species specifically adapted to riparian conditions. Instead, riparian areas are defined by spatial gradients in biophysical and ecological processes that do not necessarily depend on any particular plant species or assemblage of species.

Riparian areas can be envisioned as sets of functions extending away from wetlands and stream channels. Different riparian functions can extend different distances (Keller and Swanson 1979, Benda and Sias 1998, Naiman et al. 2000, FPAC 2000, WFPB 2004, Collins et al. 2006). Riparian areas can include those portions of terrestrial landscapes that significantly influence exchanges of energy and matter with aquatic areas (NRC 2002).

[20] http://www.epa.gov/cwa-404/section-404-clean-water-act-how-wetlands-are-defined-and-identified.

Numerous studies have defined the widths of riparian areas based on the maintenance of particular water quality and wildlife support functions. In general, the total number of functions provided by riparian areas tends to increase with their overall width and length.

What are assessment and monitoring?

This framework is intended to support standardized assessment and monitoring of wetland resources. An assessment is an observation or report of condition for one area and time period based on monitoring results. An initial assessment establishes a baseline measure of condition. Monitoring means a series of repeated assessments, as needed to measure changes in condition over time. Monitoring is essential to assess temporal trends in wetland condition.

There are three types of monitoring associated with water quality control and wildlife conservation that can be supported by this framework.

Compliance Monitoring.

HCPs, NCCPs, and the 404 and 401 Programs rely on compliance monitoring to assure that mitigation projects are consistent with their performance standards (404 Program) or performance criteria (Californian State 401 Program), and the biological goals and objectives of an HCP or NCCP (USFWS and NMFS 1996, Chipping 1999, USACE 2008, CDFG 2010, USACE 2013, CDFW 2015).

Effectiveness Monitoring.

HCPs and NCCPs rely on effectiveness monitoring to determine if their biological goals and objectives are actually being met (Atkinson et al 2004, CDFW 2015). The 404 and 401 Programs do not require effectiveness monitoring per se, but require that the performance standards and criteria of compensatory mitigation projects provide their intended functions and not degrade the aquatic resources landscape profile, which is the existing abundance, diversity, and condition of aquatic resources in the project watershed area (USACE 2013, SWRCB 2015). A more complete definition of the landscape profile is provided below.

Evaluating the effectiveness of environmental projects, programs, and policies requires ambient monitoring to assess changes in the landscape profile. Ambient monitoring involves surveys of resource conditions throughout a landscape to assess the relative, cumulative effects of projects versus large-scale, external forces of environmental change, such economy, human demography, and climate.

HCPs, NCCP, and the 404 and 401 Programs do not require or have specific guidance on how to use baseline or ambient assessments. However, it’s a well-accepted component of any effort to establish goals and objectives and to assess how well they’re being met by relevant policies, programs, and projects.

What is the relationship of monitoring and assessment to research?

This framework distinguishes monitoring and assessment from research. Monitoring and assessment reveal patterns of change in condition that are the basis for formulating hypotheses of causal relationships that are tested by research. In short, monitoring and assessment reveal how conditions change, whereas research explains why. This framework can be adapted to research by incorporating the elements of experimental design and statistical hypothesis testing into data collection and analysis.

What is a project?

For the purpose of this framework, projects are legal, on-the-ground actions that are expected to change the quantity or quality of surface waters. In the context of state regulatory review, projects are often defined according to the California Environmental Quality Act[21]. More specifically, this framework can be applied to the following four kinds of projects:

- Permitted actions on the ground that temporarily or permanently impact aquatic resources;
- Compensatory mitigation projects, including areas identified to reserve or preserve existing aquatic resources, as well as actions on the ground to create, restore, or enhance aquatic resources as compensat ion for permitted or illegal impacts;
- Actions on the ground to create, restore, or enhance aquatic resources that are not intended to compensate for permitted or illegal impacts;
- Field sites for aquatic resource monitoring or assessments that are established to implement or apply an HCP, NCCP, 404 Permit, or 401 Certification.

What is a landscape?

For the purposes of this framework, a landscape is defined as a heterogeneous inland area composed of a cluster of interacting ecosystems that is repeated in similar form throughout (Forman and Godron 1986). In other words, landscapes tend to be visually self-evident. The landscape concept differs from the traditional ecosystem concept in focusing on groups of ecosystems and their interactions. The size of a landscape is determined by the dimensions of its repeating mosaics of land use or habitats. They can be nested, one within another, as most watersheds are.

A watershed is a special kind of landscape defined as an area of land draining to a common place, as evident in the USGS Watershed Boundary Dataset (WBD) (http://nhd.usgs.gov/wbd.html), or as mapped using the USGS StreamStats tool (http://water.usgs.gov/osw/streamstats/), the online watershed mapping function of the Landscape Profile Tool of the California EcoAtlas (http://www.sfei.org/news_items/ecoatlas%25E2%2580%2599-landscape-profile-tool-v20), or other tools for resolving drainage boundaries.

What is a landscape profile?

The landscape profile is the abundance, diversity, and condition of aquatic resources in a given landscape or watershed. The coordination of aquatic resource monitoring and assessment across governmental programs can be facilitated by their common use of landscape profiles. Past profiles pertain to a previous time period. The historical profile is a past profile that pertains to the time of original European or Asian settlement. The current profile pertains to present-day conditions, although they may be represented by a recent past profile. Future profiles pertain to expected, alternative, or preferred future conditions. Ideally, an NCCP or HCP and the associated 404 Permit, 401 Certification and WDR would be based on the same preferred landscape profile.

What is the landscape approach?

The landscape approach means planning, designing, managing, and assessing aquatic resources in the landscape context. According to this approach, the cumulative effects of projects are assessed as changes in the landscape profile. This framework is designed to support the landscape approach.

[21] https://www.cnps.org/cnps/conservation/conference/2006/CEQA%20Guidelines%20-%20Definitions.pdf.

What are the relationships between condition, process, function, and ecosystem service?

For the purpose of this framework, a *process* of a system has *functions* in relation to one or more other processes or other systems. For example, the *process* of primary production in a wetland has a *function* as food to support waterfowl. *Functions* can provide *services* that have *value* in the context of human society. For example, wetland primary production that supports waterfowl also supports duck hunting as a service that has economic and other values to people. According to WRAMPw, functions and services are assessed as the status (i.e., condition) of indicative attributes, and processes are assessed as changes in condition over time.

How does WRAMPw relate to WRAMP?

The framework presented in this document is a translation of the standard WRAMP framework to apply to the landscape approaches to wildlife conservation as well as water quality improvement. It is entirely consistent with the WRAMP framework (see Figure 1 above), but is referred to as the WRAMP framework for wildlife (WRAMPw).

How does WRAMPw relate to RAMP?

Regional Advance Mitigation Planning (RAMP)[22] is being developed through a consortium of state agencies to formulate compensatory mitigation plans at the regional scale for unavoidable impacts to wildlife due to large, linear infrastructure projects, such as highways and levee systems. RAMP does not supplant an NCCP or HCP. Furthermore, RAMP doesn't address mitigation requirements to compensate for impacts to water quality. However, the preferred future landscape profile (see landscape profile definition immediately above) that results from coordinated mitigation planning across HCPs, NCCPs, the 404 Permit Program, and the 401 Certification Program could be incorporated into RAMP[23].

What is the WRAMP toolset?

The WRAMP toolset supports the watershed or landscape approach to Section 404 Permits (USACE 2013) and Section 401 Certification (SWRCB 2013). Some of the tools have been developed specifically for this purpose and others have been appropriated. In aggregate, the tools support project mapping, siting and design, tracking, assessment, ambient monitoring, synthesis and reporting of aquatic resource condition in the landscape or watershed context. The WRAMPw toolset consist of the WRAMP tools plus wildlife conservation tools. The WRAMP toolset is described in Appendix 1.

What is the wildlife conservation toolset?

No toolset has been developed to specifically support NCCPs and HCPs throughout California. HabiTrak[24] is a tool developed by the San Diego Association of Governments (SANDAG) in cooperation with CDFW and USFWS for viewing and reporting HCP and NCCP implementation efforts in the San Diego area; it has not been implemented elsewhere. However, CDFW has been developing a variety of tools focused on wildlife conservation that could be combined with the WRAMP toolset through the WRAMP framework to create a robust toolset supporting HCPs, NCPs, the 404 Permit Program and the 401 Certification Program statewide. The WRAMPw toolset consist of the WRAMP tools plus wildlife conservation tools. These wildlife conservation tools are described in Appendix 2.

[22] https://rampcalifornia.water.ca.gov/.

[23] Personal communication, Rebecca Payne Senior Wetland and Mitigation Biologist, Division of Environmental Analysis, Office of Biological Studies, California Department of Transportation.

[24] https://nrm.dfg.ca.gov/HabiTrak/About.aspx.

What is a Landscape Condition Summary Report?

A Landscape Condition Summary Report is a summary of conditions relative to the established biological objects of an HCP-NCCP, associated water quality objectives of the 404 permit, 401 certification, and any WDRs, and performance criteria of individual restoration or mitigation projects. The report features a Landscape Health Report Card) as described in Appendix 3.

Coordination Framework

The WRAMPw framework is designed for coordinating aquatic resource monitoring wetland monitoring for wildlife conservation and water quality improvement.[25] The framework has been calibrated by applying it to an existing HCP-NCCP monitoring plan (Appendix 4).

Coordinated Planning.

HCPs and NCCPs are supported by detailed guidelines that continue to evolve (Hopkins 2004, https://www.wildlife.ca.gov/Conservation/Planning/NCCP/CDFW-Guidance). Likewise, 404 Permits and 401 Certifications are supported by abundant, detailed guidance developed over many decades of implementation (NAP 2001, Gardner et al 2009, http://www.epa.gov/cwa-404/policy-and-guidance). However, none of the existing guidance formally addresses the need to coordinate planning across HCPs, NCCPs, the 404 Program, and the 401-WDR Program (Camacho et al 2016). Coordination is increasing through the efforts of program leaders and staff (e.g., Jewell 2012), but formal guidance is lacking (Camacho 2016). Since HCPs and NCCPs must be permitted and certified under CWA Sections 404 and 401, a lack of coordination across these programs can lead to permit delays (Porter and Salvesen 1995, Dennis 1997, Northern California Wetlands and Endangered Species Permits Working Group 2004, EPS 2014, Camacho 2016). While there are significant policy matters to address for the coordination to succeed, a scientific framework and technical toolset are needed to implement the coordination. This framework can help provide the framework and toolset that are needed.

Coordinated Monitoring and Assessment.

The WRAMPw framework applies equally well to compliance monitoring, effectiveness monitoring and ambient monitoring, as needed for wildlife conservation and water quality improvement. It is generally applicable to environmental adaptive management by guiding its monitoring component. As explained below, it can be adapted to research by exchanging monitoring design and reporting for experimental design and hypothesis testing. However, the focus here is on joint application of the framework to HCPs, NCCPs, the 404 Program, and the state's 401-WDR Program.

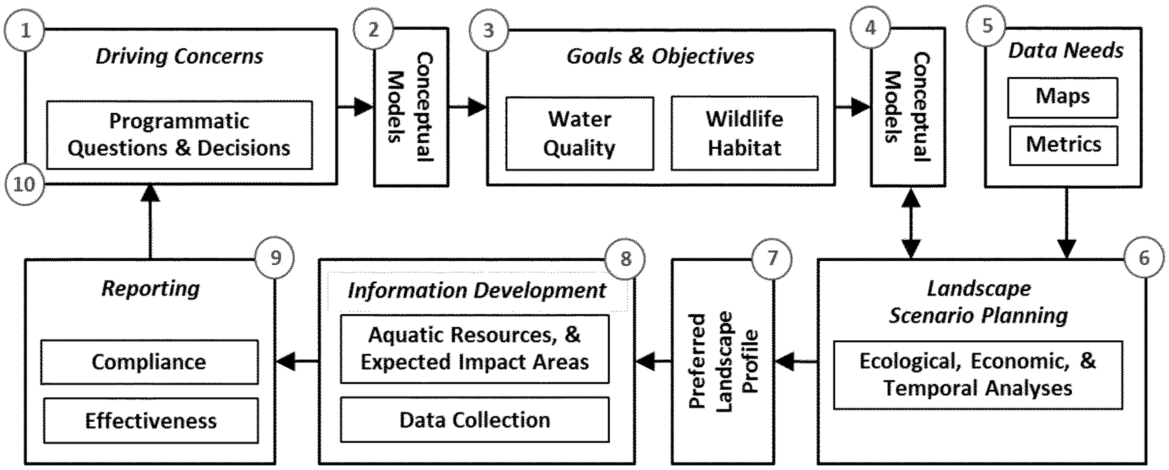
Wildlife conservation and wetland protection require similar kinds of monitoring. Both need assessments of compliance, effectiveness, and ambient conditions. The implementing agreements for HCPs and NCCPs require that local agencies prepare annual reports that track habitat loss and mitigation associated with public and private land development. The annual reports are used to demonstrate that habitat loss is occurring in rough proportionality with development, to ensure that any and all habitat preserves are being assembled as agreed to in the implementing agreements, and to make certain that the biological goals and objectives are being met. Likewise, water quality permits issued through the 404 and 401-WDR programs require permittees to annually report the performance of permitted activities relative to their performance criteria.

[25] This version of the WRAMP framework is adopted from the version developed solely for water quality control, which can be found at http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/#frame.

Description of the WRAMPw Framework.

The WRAMPw framework can be visualized as 10 sequential Steps (Figure 2) to coordinate the landscape or watershed approach to wildlife conservation under ESA and NCCPA, as well as wetland and stream protection under CWA and Porter Cologne. Joint use of the framework should lead to the formulation of a shared, preferred future landscape profile. It will not address all the biological goals and objectives for an HCP or NCCP, since some will pertain to terrestrial wildlife. It also might not address all aspects of water quality improvement, but should not conflict with efforts to achieve them.

Figure 2: Stepwise framework based on WRAMP for deciding the preferred landscape profile.



Step 1: Driving Concerns

The first Step in this framework, as jointly applied to wildlife conservation and wetlands protection, involves identifying the specific concerns warranting an HCP or NCCP, as well as the water quality concerns pertaining to the same landscape or watershed. The complete list of concerns will usually include one or more wildlife species of special status, land development pressures, water body impairment (as defined under CWA and Porter-Cologne) [26], the existence of high-quality waters subject to the SWRCB antidegradation policy,[27] and opportunities to achieve water quality improvements through point-source and non-point source pollution control.

Step 2: Conceptual Models for Goals and Objectives

Conceptual models of the processes affecting habitat quality for the target wildlife are an important component of wildlife conservation planning (Atkinson et al. 2004, Margoluis et al, 2009, Hoshi 2015). Conceptual models are also a component of the rationale for water quality objectives and standards, especially in the watershed or landscape context (Petts and Kennedy 2005), given that relationships between water quality and landscape processes are not always well understood. The models should consist of arrows that represent processes and boxes that represent key aspects of habitat or water quality that the processes affect.

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[26] http://www.waterboards.ca.gov/water_issues/programs/tmdl/docs/iw_guidance.pdf, http://www.epa.gov/tmdl.

[27] http://www.swrcb.ca.gov/plans_policies/antidegradation.shtml.

The models should reflect what is known as scientific fact, what can be extrapolated from the facts, and what is likely based on consensus professional judgement. The models should indicate which of these three levels of scientific certainty applies to each interrelationship depicted by the models.

Conceptual models can be supported by quantitative models if they are available. All the major assumptions of the models should be documented. The models will be used to rationalize the wildlife conservation goals and objectives as well as the water quality objectives, as represented by the preferred landscape profile.

Separate models might be needed to cover different target species of wildlife and different water quality concerns. However, to the full degree possible, functional links between the different models should be identified. These links will indicate processes and factors that should be managed collaboratively across the programs for wildlife conservation and water quality improvement. Environmental processes and factors that are common to multiple conceptual models indicate opportunities for coordination.

The models can be configured according to the pressure-state-response template or its variants (Kjellström and Corvalán 1995, Niemeijer and de Groot 2008). This configuration can help identify conditions (states) apart from their causes (pressures or stressors), in relation to regulatory or management goals, objectives, and actions (responses).

Step 3: Goals, Objectives, Performance Criteria and Monitoring Questions

This Step involves setting the overarching biological goals and objectives for wildlife conservation, and assembling the pertinent water quality objectives and standards. It also involves formulating performance criteria for individual actions, such as local habitat restoration or mitigation projects. The biological goals and objectives are set using established guidance,[28] which includes conceptual modeling at Step 2. The water quality objectives should reflect any relating to relevant watershed- or landscape-based plans and permits for water quality control, such as agricultural waivers, timber harvest plans, stormwater management plans, regional permits including state Municipal Regional Permits (MRPs), federal Regional General Permits (RGPs) and federal Special Area Management Plans (SAMPS). The project-specific performance criteria should be consistent with all of the above while reflecting local opportunities and constraints.

Typical ambient monitoring concerns are about the status and trends in overall abundance, diversity and condition of aquatic resources within a prescribed area; to what degree policies and programs are achieving their missions; and how policies and programs might be adjusted to improve their effectiveness. Ambient monitoring is needed to determine if baseline conditions are changing in such ways as to warrant adjustments in the goals, objectives, and performance criteria.

Once the goals, objectives, and performance criteria have been set, they must be translated into monitoring questions. These are the questions that will be answered through monitoring and assessment to address the driving concerns. The questions must be specific enough to guide monitoring designs, including especially the identification of data needs (Step 5). For example, some of the questions for an HCP-NCCP might be:

- What is the acres of riverine riparian habitat, relative to the riparian goals and objectives;

[28] Atkins et al. 2004, http://www.fws.gov/endangered/what-we-do/hcp-overview.html, https://www.wildlife.ca.gov/Conservation/Planning/NCCP.

- What percentage of verbal pools within the boundary of the HCP-NCCP support target species of amphibians or tadpole shrimp;
- What is the overall condition of the depressional wetlands;
- Does the median concentration of coliform bacteria in any stream covered by the HCP-NCCP exceed the water quality objective of 240 MPN/100ml?

Step 4: Conceptual Models for Monitoring Design

Conceptual modeling at Step 4 builds on the models developed at Step 2. The purpose of this additional modeling is to identify existing or new data that must be acquired or formatted to answer the monitoring questions developed at Step 3. This is achieved by using the conceptual models developed at Step 2 to recommend what to monitor, where to monitor, and when to monitor (Step 5). It's useful to annotate the models with the monitoring questions by identifying the boxes and arrows of the models that will contribute to the answers. The models developed at Step 2 and the monitoring questions developed at Step 3 can be modified based on the additional modeling done at this Step 4.

Step 5: Data Needs

Data will be needed to assess the conditions or states of factors and processes that the conceptual models suggest are most directly related to the monitoring questions and hence the driving concerns. These might be termed the key conditions because they indicate whether or not the goals and objectives are being met. As stated for Step 2 above, the models can be configured according to the pressure-state-response template, in which case the priority data will pertain to states rather than pressures. Causal factors or processes (i.e., pressures or stressors) should not be monitored or assessed unless warranted by a sound determination that the goals and objectives are not being met, in which case a special study of the hypothesized causes might be conducted to help identify corrective actions, which might involve revising the goals and objectives.

Monitoring and assessment should not automatically attempt to assess the causes of key conditions; relegating causal analyses to special studies warranted by inadequate progress toward goals and objectives can significantly reduce monitoring and assessment costs.

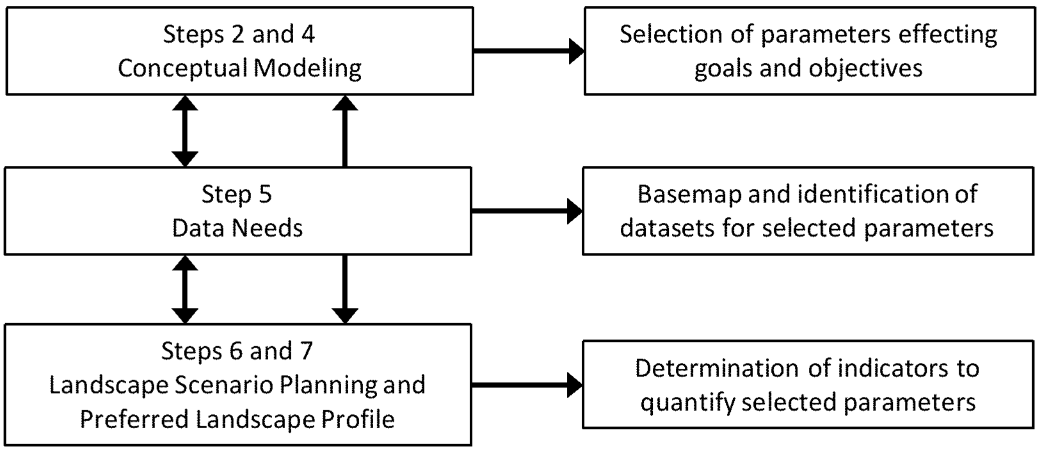
A dataset represents a parameter, such as stream flow, plant cover, pollutant abundance, or habitat abundance that is necessary to quantify one or more key conditions. To the extent practicable, monitoring and assessment should utilize and build onto existing datasets rather than generate unnecessarily redundant new data.

The datasets are used to quantify the parameters as indicators of the key conditions. The indicators might represent a single parameter, or they can be indices that represent multiple parameters quantified from different datasets. Example indices include the California Rapid Assessment Method (http://www.cramwetlands.org/), and the California Stream Condition Index (http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/docs/csci_tech_memo.pdf). According to WRAMP, indicators and metrics are synonymous.

As stated above (Step 2), indicators can be classified based on their representation of environmental pressures, states, or management or regulatory responses. They can also be classified as lagging or leading indicators. Lagging indicators are used to assess existing conditions, whereas leading indicators are used to assess likely future conditions. Leading indicators are usually based on well-known cause-and-effect relationships represented by the conceptual models (Steps 2 and 4). Some indicators can be lagging indicators in some regards, and predictive indicators in other regards. For example, the hydroperiod of a wetland may serve to indicate existing hydrological conditions and to predict future conditions for related indicators such as stream stability or wetland plant community structure. The selected indicators should be classified as lagging or leading, based on the conceptual modeling.

The chosen indicators should be reviewed based on the preferred landscape profile (Step 7), which will help define data needs. The relationship among steps in the WRAMPw framework and the selection or development of datasets, parameters, and indicators is illustrated below (Figure 3).

Figure 3: Relationship among steps in this framework and the selection or development of datasets, parameters, and indicators.



Analytics are the graphic and statistical methods of data analysis that will be used to summarize the monitoring results and translate them into information (Step 8). It's important to select the analytics during the identification of data needs to make sure that all the data needed for the analyses are collected during monitoring. The analytics should include procedures for data quality assurance and quality control (QAQC). QAQC procedures have been prepared for methods of water quality data collection adopted by the Surface Water Ambient Monitoring Program (SWAMP) of the State Water Board (http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml).

In addition to being classified as lagging or leading, every indicator can also be classified into one of three categories or levels, based on the classification system developed by the USEPA (http://water.epa.gov/grants_funding/wetlands/monitoring.cfm). The 3-level system can be described as follows:

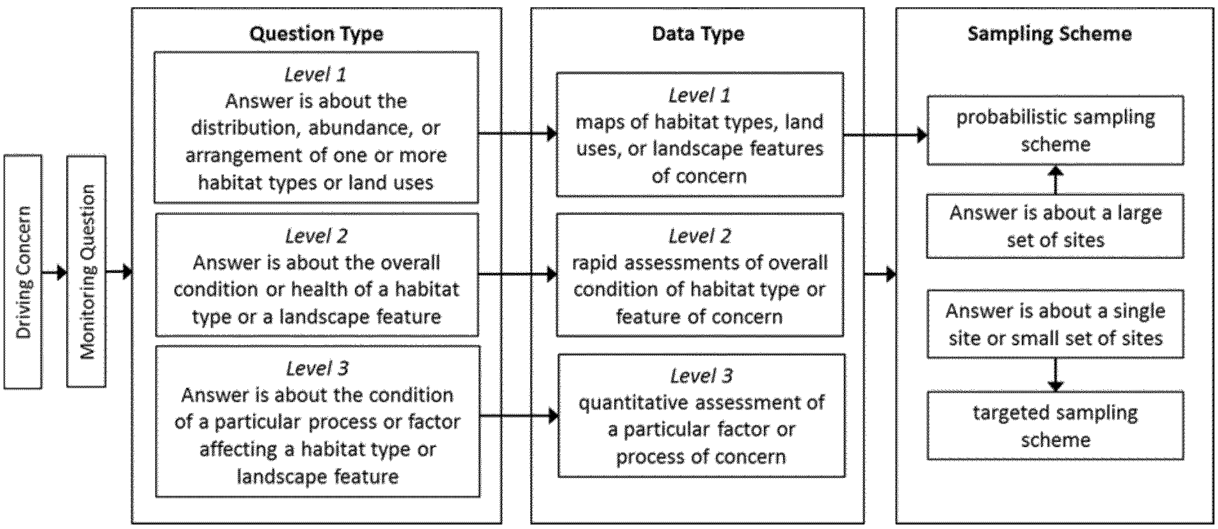
Level 1 (L1) includes maps and other inventories and databases for environmental information, plus the data and indicators provided by these sources, as well the methods to create them. Examples of L1 data include the National Hydrography Dataset (http://nhd.usgs.gov/), California Aquatic Resource Inventory (http://www.sfei.org/it/gis/cari), and California Natural Diversity Database (http://www.dfg.ca.gov/biogeodata/cnddb/).

Level 2 (L2) includes rapid field assessments of habitat condition. Rapid assessments typically require less than a day to apply at least once, and do not rely on the collection of field materials or any laboratory analysis. Most Level 2 methods are qualitative or semi-quantitative. Examples of L2 methods include Proper Functioning Condition (PFC) (http://www.blm.gov/or/programs/nst/pfcassess.php) and the California Rapid Assessment Method for wetlands and streams (CRAM) (http://www.cramwetlands.org/).

Level 3 (L3) includes methods to quantify one or more aspects of environmental condition or stress, relative to others aspects, or per unit time or space. An example L2 method is the California Stream Condition Index (CSCI) of the State Water Board (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/cabw2012/two_assess_score_mazor_csci.pdf).

The USEPA 3-level system is an integral component of this framework. Monitoring costs tend to increase with the level of monitoring data and methods. It is useful therefore to explore how the use of existing data and new Level 1 and Level 2 data can be optimized. Each requirement for new Level 3 data should be carefully rationalized to account for their relatively high cost. The framework can include additional L1-3 SOPs based on rigorous field testing and vetting with intended user communities. The L1-3 system is further explained in Appendix 1. A decision flow diagram tree has been developed to assist with data selection and classification (Figure 4 below).

Figure 4: Decision tree to identify the highest priority data and appropriate sampling scheme based on the WRAMP framework. Level 1 data (maps) of habitat types, landscape features, and land uses of interest will be needed to support any probabilistic sample of their condition or effect.



Once the monitoring methods have been selected, a plan of data collection must be developed. As stated above, every monitoring plan should maximize the use of existing data, and the collection of new data should focus on L1 and L2. The collection of relatively expensive L3 data should be carefully rationalized.

The WRAMP toolset supports targeted sample designs that use fixed sampling sites, random designs that draw sampling sites at random from a population of possible sites within the geographic scope of the monitoring and assessment effort, and probabilistic designs that account for the probability of any candidate site being included in a random sample. The toolset also supports exhaustive surveys of wetland and stream condition, which consist of assessments of every wetland or stream within a prescribed survey area. The best choice in sampling design can depend on the monitoring questions and geographic scope. USEPA provides online help in choosing sampling designs (http://www.epa.gov/quality/qs-docs/g5s-final.pdf).

For monitoring questions that can be addressed with Level 1 data, an exhaustive survey is often most appropriate. Budget constraints usually preclude exhaustive surveys using L2 or L3 methods, unless the scope of the survey is small. A targeted design is required to track changes in condition for fixed sites, such as reference sites, over time. Concerns about the overall condition of aquatic resources for large areas are usually best addressed using a probabilistic sampling design. Online help with probabilistic designs for aquatic resources is provided by USEPA (http://www.epa.gov/nheerl/arm/designpages/monitdesign/survey_overview.htm).

A base map is needed for visualizing and sharing information about on-the-ground actions related to either wildlife conservation or water quality improvement. With regard to aquatic resources, the map must show all state and federal surface waters in sufficient detail to inform local planning and assessment. As part of the case study, criteria have been drafted for designing and evaluating a base map, and for selected sources of basemap data (Appendix 3).

Expert review of the base map by its users is a key aspect of its development. The experts should be assembled from the community of base map users as a technical advisory committee (i.e., a "base map TAC"). The TAC will need to advise the initial and ongoing development of the base map.
Expert review of the base map by its users is a key aspect of its development.

A base map of surface water, vegetation, and topography that commonly serves all interests in water quality improvement and wildlife conservation is the single most important technical tool for their coordination.

Step 6: Landscape Scenario Planning

Landscape scenario planning is a way to explore alternative future landscapes based on different natural resource management goals and objectives. For the purposes of this framework, landscape scenario planning is conducted to determine the future abundance, diversity, and spatial arrangement of surface waters including the attending riparian areas most likely to meet the goals and objectives for wildlife conservation and water quality improvement in the context of forecasted changes in human demographics and climate. In other words, landscape scenario planning is conducted to define the preferred landscape profile (Step 7).

Many studies have defined landscape scale scenarios using qualitative techniques based on participation of stakeholder groups (Hulse et al. 2004; Patela et al. 2007). Others have combined participatory approaches with quantitative systems modelling (Bellman, 2000), which can be coupled with GIS to assist watershed planning and management (Stoms et al. 2004, Liu et al. 2007, Parrott and Meyer 2012). Scenario planning can include the costs of acquiring lands or conservation easements plus other social and economic considerations. Landscape scenario planning can serve to organize social, economic, and ecological aspects of environmental planning (Rosenberg et al. 2014). The independent science panes of an HCP or NCCP can serve to steer landscape scenario planning.

Landscape scenarios are defined as descriptions of how a landscape will develop over a prescribed future period, based on a set of assumptions about how the landscape will respond to management and natural drivers (Rotmans et al. 2000, Alcamo 2008). There are two basic approaches to formulating scenarios (Rosenberg et al. 2014); they may be developed as a narrative storyline, or they can be developed from quantitative approaches involving simulation models linked to a geographic information system (GIS) (Steinitz 2003). In either case, alterative versions of the future are compared based on their likely ability to meet large-scale and long-term management objectives (Nassauer and Corry 2004).

This framework does not specify any particular approach to landscape scenario planning. However, given that achieving the goals and objectives for wildlife conservation and water quality improvement involves altering the abundance, diversity and arrangement of habitat types, landscape features, and land uses, it seems likely that the scenarios will be depicted in a GIS. It is also essential that the formulation adheres to the established guidelines for developing HCPs (USFWS and NOAA 1996) and NCCPs (CDFW 2015). The Regional Advanced Mitigation Planning tool RAMP[29] involves landscape scenario planning to mitigate for wildlife habitat impacts that could be coupled to landscape scenario planning to mitigate for water quality impacts. More detail about the possible output of landscape scenario planning is presented immediately below (Step 7).

Step 7: Preferred Landscape Profile

As stated above, landscape scenario planning is conducted to define the preferred landscape profile. The planning will be guided by the goals, objectives, and performance criteria of Step 3, and the conceptual models of Steps 2 and 4, with the intent of optimizing the profile for both wildlife conservation and water quality improvement. The preferred profile must be consistent with the published guidance[30] for HCPs, NCCPs, 404 Permitting, 401 Certification, and Waste Discharge Requirements (WDR). This will involve the following general considerations.

- Impacts to wildlife species of special status, natural communities, and water quality due to anticipated land use change, including new development and maintenance of infrastructure.
- Monitoring by the permittee to avoid and minimize such impacts, and the procedures to deal with unforeseen or extraordinary circumstances.
- The funding available to achieve the preferred landscape profile and to implement all other aspects of the agreements and permits, including but not necessarily limited to:
    - Adaptive management, which includes compliance and effectiveness monitoring;
    - Actions taken to conserve wildlife and improve water quality - for example, stormwater can be managed to reduce its negative effects on water quality while supporting wildlife (Brittingham 1991, Lehner et al. 1999, Adams and Lindsey 2010);
    - Additional measures that the USFWS, NMFS, SWRCB, or CDFW may require.
- Duration of permits and agreements, which is determined as the time needed to achieve the goals, objectives, and performance criteria for wildlife conservation and water quality improvement.
- Public participation according to the National Environmental Policy Act (NEPA), and California Environmental Quality Act (CEQA).

[29] https://rampcalifornia.water.ca.gov/.
[30] For HCP: Atkins et al. 2004, http://www.fws.gov/endangered/what-we-do/hcp-overview.html.
For NCCP: https://www.wildlife.ca.gov/Conservation/Planning/NCCP.
For the 404 Program: http://www.epa.gov/cwa-404/section-404-permit-program.
For the 401-WDR Program: http://www.waterboards.ca.gov/water_issues/programs/cwa401/;
http://www.waterboards.ca.gov/water_issues/programs/land_disposal/waste_discharge_requirements.shtml

It is assumed that coordination between wildlife conservation and water quality improvement at the landscape scale requires that the preferred landscape profile serves as the performance standard and criterion for the landscape or watershed approach to 404 Permitting, 401 Certification, and WDRs, as well as for HCPs and NCCPs.

Based on this assumption, some Level 1 and level 2 indicators to consider for quantifying the preferred landscape profile are provided below (Table 1). Their consideration can inform the identification of the key indicators of condition used to assess compliance and effectiveness. Therefore, the decisions made at Step 5 should be reviewed in the context of these considerations. To be more specific, each of the indicators used to quantify the profile must serve as an indicator of conditions as defined at Step 5, and as informed by the conceptual modelling from Steps 2 and 4.

The same indicators listed in Table 1 can be calculated for historical conditions, if the necessary data are available. The historical profile can help inform the development of goals and objectives (Step 3) by revealing the full range of habitat types and their interrelations across the landscape (Grossinger 1999, Swetnam et al. 1999) and reversible environmental impacts resulting from past land use and management practices (Swetnam et al. 1999, Hobbs et al. 2009).

Table 1: Possible Level 1 and Level 2 indicators to be for quantifying the preferred landscape profile.

Habitat Indicators	Land Use Indicators
Total acres of each habitat type	Total acreage of each land use type
Total number of habitat types	Patch size-frequency of each land use type
Relative abundance of the habitat types	Road density
Patch size frequency for each habitat type	Percent impervious area
Inter-patch distance frequency for each habitat type (i.e., connectivity)	Adjacency between habitat types and land use types (i.e., landscape context)
Relationship between size of area and number of patch types contained therein (i.e., habitat mosaic size and complexity)	Total area of each habitat type permanently protected
Cumulative Frequency Distribution of CRAM scores for wetlands and streams*	Percent of each habitat type permanently protected
Drainage network density	
Percent of natural drainage network	
Percent longitudinal riparian continuity	
Riparian width frequency based on RipZET	

* This is the only L2 indicator listed in Table 1. Calculation of this indicator requires a probabilistic survey of the condition of each target aquatic habitat type using CRAM or a comparable L2 method.

Step 8: Information Development

This is the most technically demanding and expensive Step of this framework. It involves making annotated maps of projects and sampling sites, data collection, and data analysis and interpretation. Each of these activities requires careful attention to many details that differ among monitoring and assessment programs. Only the most basic aspects of the activities are noted below. The base map is discussed above as part of Step 5.

- Archiving Projects and Sampling Sites. Digital maps of the projects and ambient monitoring sample sites should be uploaded to the Project Tracker using the Project Uploader (http://www.ecoatlas.org/uploader/). Sample sites can be represented as dots, but each project should be represented by a polygonal map of its boundaries. Projects that consist of multiple disjoined areas can be represented by multiple polygons. The locations of sample sites within projects do not have to be mapped. The dots that represent ambient sample sites and the polygonal maps of projects can serve as interactive repositories for monitoring and assessment data and reports (Step 9).

- Data Collection. All data should be collected as planned in Steps 1-7.
- Data Analysis and Interpretation. Any procedures for data QAQC and analysis that accompany the selected datasets and indicators (Step 5) should be rigorously implemented. QAQC procedures must be developed for any other indicators.

  Data interpretation means translating the monitoring results into information that answers the monitoring questions (Step 3), and thusly addresses the driving concerns (Step 1). Interpretation can be aided by the advice and review of an independent third party, such as a technical advisory committee. Independent scientific advisors are a strongly recommended component of HCPs and NCCPs, and could likewise be included in the landscape or watershed approach to 404 Permitting and 401 Certification.

  If the monitoring results do not provide an adequate assessment (i.e., if they cannot answer the monitoring questions), the monitoring plan will need to be revised beginning with Step 1 of this framework (see Step 10).

Step 9: Reporting

Finalized information about mitigation and restoration projects should be uploaded into the interactive repositories provided in Project Tracker (http://ecoatlas.org/about/#project-info) (Step 8) of EcoAtlas (http://www.ecoatlas.org/). Water Quality data collected using protocols provided by the Surface Water Ambient Monitoring Program (SWAMP) can be uploaded into the California Environmental Exchange Network (CEDEN) (http://www.ceden.org/ceden_submitdata.shtml). Other datasets relating to wildlife should be uploaded into the Biogeographic Information and Observation System (BIOS) (http://www.dfg.ca.gov/biogeodata/bios/). In addition, the capacity is being developed to upload maps of monitoring sites into Project Tracker and to annotate the maps with Level 2 and Level 3 data. Likewise, maps of landscape- or watershed-based plans including HCPs and NCCPs can be uploaded and annotated with their plans, annual reports, and other summary information. Project Tracker can therefore be used to deliver datasets and reports to clients, sponsors, and other interests through EcoAtlas.

An optional approach to uploading datasets and reports directly to Project Tracker is to enable the Project Tracker to access them using web services. Web services provide a standard means of interoperating between software applications running on a variety of platforms and frameworks. Simply stated, web services allow users of one online database or delivery system to access data in other databases and systems, given appropriate data sharing protocols. One advantage of using web services is that the datasets and reports can be delivered through Project Tracker without having to exist within the Project Tracker database. This also means that monitoring information can be accessed from Project Tracker through any other appropriate online databases or delivery systems. For example, the Landscape Profile Tool of EcoAtlas (Appendix 2) uses web services to access data from a variety of sources, including NDDB from BIOS, while NWI can access CARI from its database and deliver CARI through the NWI website.

All the outputs for one monitoring period comprise an assessment. The exact content and configuration of an assessment will differ for an HCP, NCCP, 404 Permit or 401 Certification. It is anticipated, however, that each assessment report should chronicle the effects of permitted actions on the landscape profile, relative to the preferred profile, while succinctly addressing the monitoring questions. Equivocal findings should be appended with recommendations to revise the monitoring plan as needed to increase the certainty of its findings (also see Step 10 below). If the purpose of the assessment is to support a regulatory or management decision, the findings must be formatted to fit neatly into the decision process. Formatting the assessment to fit the decision process can involve input from the decision makers.

A report of the overall condition of a landscape, relative to all or many of the goals and objectives for its management, is called a Landscape Condition Summary Report, or Landscape Health Report Card (Appendix 3). Such reports can be very important for assessing and communicating the overall return on public investments in wildlife conservation and water quality improvement.

Step 10. Revisit the Driving Concerns

The final Step in the framework is to consider how well an assessment has addressed the driving concerns (Step 1), if they need to be revised, and to determine if there are new concerns that need to be addressed through additional or revised monitoring or special studies. If the monitoring results do not provide an adequate assessment (i.e., if they cannot address the driving concerns), the monitoring design will need to be revised. This could involve any of the Steps of the framework, including Steps 1 and 3. That is, the assessment may indicate a need to revise the driving concerns and /or the goals and objectives.

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Appendix 1: Description of WRAMP Tools

Introduction

The WRAMP toolset supports the watershed or landscape approach to Section 404 Permits (USACE 2013) and Section 401 Certifications (SWRCB 2013). Some of the tools have been developed specifically for this purpose and others have been appropriated. The toolset supports project siting and design, tracking, assessment, ambient monitoring, information synthesis and reporting about aquatic resource condition in the landscape or watershed context. The WRAMP toolset is organized according to the there-level classification system developed by USEPA for wetland monitoring methods (http://water.epa.gov/grants_funding/wetlands/monitoring.cfm)

Level 1-3 data are often integral components of a monitoring plan. For example, L1 maps of the aquatic resources or projects can serve as the sample frame for data collection using L2 or L3 methods. In some cases, strong positive correlation between L2 and L3 data can justify using less expensive L2 methods as proxies for L3 methods. WRAMP can include additional L1-3 SOPs that involve statewide technical advisory committees, rigorous field testing, and vetting with intended user communities.

Level 1 (L1)

Level 1 includes maps and other inventories and databases for environmental information, plus the data and indicators provided by these sources, as well the methods to create them. L1 methods are necessary to answer monitoring questions about the location, distribution, abundance and diversity of aquatic resources and related projects in the watershed or landscape context. They are also useful for project siting and design. Key L1 tools for assessing wetlands are briefly described below.

Base Map

All mapping depends on L1 tools, including the production of base maps. Shared base maps are foundational to coordinated monitoring and assessment across programs.

To facilitate their coordination, all on-the-ground actions of any programs affecting the abundance, diversity, or condition of aquatic resources should be accurately inscribed on the same base map.

The fundamental components of a base map to serve both wildlife conservation and water quality improvement are topography, hydrography (i.e., surface waters), and vegetation. The primary sources of topographic and hydrographic data are described below. The primary sources for vegetation data are considered part of the wildlife conservation toolset and are therefore described in Appendix 2.

The 3D Elevation Program (3DEP).

3DEP of USGS (http://nationalmap.gov/elevation.html) provides high-quality topographic data and a wide range of other three-dimensional representations of natural and constructed features throughout the U.S. The primary goal of 3DEP is to systematically collect enhanced elevation data in the form of high-quality light detection and ranging (LiDar) data. With 3DEP operational, seamless bare-earth Digital Elevational Models (DEMs) that were previously called the National Elevation Dataset (NED) are distributed in geographic coordinates at 1/3, 1, and 2 arc-seconds. Two high resolution layers over the conterminous U.S., 1/9 arc-second and 1-meter, are seamless within data acquisition projects but not across projects. The 1-meter bare earth DEM dataset will be populated as new data are acquired in 2015 and beyond. Each of the seamless bare-earth DEM layers is derived from the highest quality DEMs available for any geographic location.

National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD).

NHD and WBD are products of the USGS (http://nhd.usgs.gov/). NHD is used to portray the drainage network with features such as rivers, streams, canals, lakes, ponds, coastline, dams, and the locations of stream gauges operating by the USGS. WBD represents drainage basins as enclosed areas in eight different size categories. Both datasets represent the real world at a nominal 1:24,000-scale. To maintain mapping clarity, not all water features are represented and those that are use a moderate level of detail. CARI (see below) intensifies NHD with additional information in greater detail.

National Wetland Inventory(NWI).

NWI is a product of the USFWS (http://www.fws.gov/wetlands/). NWI includes wetland maps and geospatial wetland data for the entire US to project and report on national wetland trends. CARI (see below) intensifies NWI with additional information in greater detail.

California Aquatic Resource Inventory (CARI).

CARI (http://www.sfei.org/it/gis/cari) is a standardized statewide map of surface waters, including tidal areas, wetlands, rivers, streams, and lakes . CARI v0 is a compilation of the best available digital maps, including the National Hydrography Dataset (NHD) of the USGS (http://nhd.usgs.gov/), the National Wetland inventory (NWI) of the USFWS (http://www.fws.gov/wetlands/), as well as maps produced by regional and local agencies. The CARI Standard Operating Procedure (SOP) provides detailed instructions for mapping and classifying surface waters consistent with standards provided by the Federal Geographic Data Committee (FGDC) and with enough detail and accuracy to inform local land use plans. CARI includes an online editing tool (http://ecoatlas.org/about/#cari-editor) to help assure that CARI remains current. CARI serves as the base map for EcoAtlas, and other Level 1 tools, including Project Tracker and the Landscape Profile Tool.

Basic Ancillary Data

There is a variety of data that are usually overlaid on the base map to help visualize and analyze the environmental context for actions to conserve aquatic and wetland wildlife and to improve water quality. The most common of these datasets are described below.

Web Soil Survey (WSS).

The WSS (http://www.nrcs.usda.gov/wps/portal/nrcs/main/ca/soils/).provides access to soils data and information produced by the National Cooperative Soil Survey of the NRCS. NRCS has soil maps and data available online for more than 95 percent of the nation's counties including all of California. The site is updated and maintained online as the single authoritative source of soil survey information in the U.S.

Parameter elevation Regression on Independent Slopes Model (PRISM)

PRISM (http://www.prism.oregonstate.edu/) is a national set of monthly, yearly, and single-event data for mean air temperature, max/min temperatures, dew points, and precipitation for the United States. The PRISM products use a weighted regression scheme to account for complex climate regimes associated with orography, rain shadows, temperature inversions, slope aspect, coastal proximity, and other factors. Mean data are available at 30-arcsec (800 meter) resolution and monthly data are available at 2.5 arcmin (4 km) resolution. PRISM is the USDA's official climatological data. - f

California Natural Diversity Database (CNDDB).

The CNDDB (http://www.dfg.ca.gov/biogeodata/cnddb/) inventories the status and locations of special status plants, animals, and natural communities in California. The goals of the CNDDB are to provide the most current data available on the state's most imperiled wildlife species, and to provide tools to analyze these data. The CNDDB concentrates on areas of the state with active NCCPs and/or HCPs, and high priority areas identified by CDFW and USFWS.

National Land Cover Database (NLCD 2011).

NLCD 2011 (http://www.mrlc.gov/index.php)[31] is the most recent national land cover product created by the Multi-Resolution Land Characteristics (MRLC) Consortium. NLCD 2011 provides the capability to assess comprehensive, spatially explicit, national land cover changes and trends across the United States from 2001 to 2011. NLCD 2011 recognizes 16-class land cover types in a classification scheme that has been applied consistently across the United States at a spatial resolution of 30 meters. NLCD 2011 is based primarily on a decision-tree classification of circa 2011 Landsat satellite data.

National Agricultural Imagery Program (NAIP)

NAIP (http://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/) acquires aerial imagery during the agricultural growing seasons in the continental US. primary goal of the NAIP program is to make digital, georectified, orthogonal (vertical) aerial photography available to governmental agencies and the public within a year of acquisition. NAIP is administered by the Farm Service Agency (FSA) of the US Department of Agriculture. NAIP imagery is acquired at a one-meter ground sample distance (GSD) with a horizontal accuracy that matches within six meters of photo-identifiable ground control points, which are used during image inspection. The default spectral resolution is natural color (Red, Green and Blue, or RGB) but beginning in 2007, California has been delivered imagery with four bands of data: RGB and Near Infrared. All imagery is inspected for horizontal accuracy and tonal quality.

Riparian Zone Estimator Tool (RipZET).

RipZET (http://www.sfei.org/content/key-project-documents) is a modular modeling tool that operates in a GIS on a basemap of aquatic resources, such as CARI (http://www.sfei.org/it/gis/cari), to estimate the extent of riparian areas for different sets of riparian functions. RipZET can be run on entire watersheds or selected wetlands and stream reaches. The modules can be run separately or together. The output consists of measures of riparian area for each set of riparian functions, and can be easily converted to measures of area per riparian width class. The contributions of each stream type (i.e., natural or unnatural channels of each stream order) and wetland type to the total riparian area for each set of functions can also be determined. RipZET can operate on the EcoAtlas base map (see discussion of base map above), or on a custom DEM and vegetation map.

[31] Some regions of the state have their own land cover datasets that provide greater detail about more types of cover and greater spatial resolution the NLDC 2011. For example, NOAA maintains a separate map of coastal land cover as part of its Coastal Change Analysis Program (https://coast.noaa.gov/digitalcoast/tools/lca).

Statewide Information Delivery Systems

There are a few statewide tools for managing and delivering information about wetlands that are regarded as part of the WRAMP toolset. The most useful of these tools are described below

California Environmental Data Exchange Network (CEDEN).

CEDEN (http://www.ceden.org/) is the data management system used by the State Water Resources Control Board for surface water quality in California. Anyone can access CEDEN data online, or submit new data through one of the regional data centers

Regulatory In lieu fee and Bank Information Tracking System (RIBITS).

RIBITS (https://ribits.usace.army.mil/ribits_apex/f?p=107:2:3921993852240::NO:RP) was developed by the U.S. Army Corps of Engineers with support from the Environmental Protection Agency, the U.S. Fish and Wildlife Service, the Federal Highway Administration, and NOAA Fisheries to provide better information on mitigation and conservation banking and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, service areas, as well information on national and local policies and procedures that affect mitigation and conservation bank and in-lieu fee program development and operation.

Project Tracker.

The Project Tracker (http://ecoatlas.org/about/#projectinfo) is a tool within the California EcoAtlas (http://www.ecoatlas.org/) that supports mapping, tracking, and reporting on projects. Maps of projects can be uploading or developed online, through heads-up, on-screen digitizing. The project maps serve as file folders for uploading and accessing project information, including images, movies, links to websites, reports and flat files of monitoring data. The tool can be expanded to incorporate monitoring and research field sites as a category of projects.

Landscape Profile Tool.

The Landscape Profile Tool (http://www.sfei.org/news_items/ecoatlas%25E2%2580%2599-landscape-profile-tool-v20; https://www.youtube.com/watch?v=paznjCGRINA) is a tool within the California EcoAtlas (http://www.ecoatlas.org/) that summarizes existing information about aquatic resources and related information into standardized reports for any user-defined area of California, and for selected pre-determined areas, including counties, congressional districts, and HUC12 watersheds. The L:andscape Profile Tool currently incorporates information from CARI (http://www.sfei.org/it/gis/cari), Project Tracker (http://ecoatlas.org/about/#projectinfo), The California Natural Diversity Database (http://www.dfg.ca.gov/biogeodata/cnddb/), National Land Cover Database (http://www.mrlc.gov/nlcd2011.php), US Census (http://www.census.gov/), the CRAM database (http://www.cramwetlands.org/) and the California Environmental Data Exchange Network (http://www.ceden.org/). Access to additional datasets will be provided in the future to serve state and federal aquatic resource protection programs.

California EcoAtlas (EcoAtlas).

EcoAtlas (http://www.ecoatlas.org/) provides free access to information for effective aquatic resource management. The maps and tools can be used to create a complete picture of wetlands and streams in the landscape or watershed context by integrating stream and wetland maps, project information, and monitoring results with land use, transportation, and other information. EcoAtlas helps access, visualize, and summarize information about the distribution, abundance, diversity, location, and condition of California wetlands, streams, and riparian areas.

Level 2 (L2).

Level 2 includes indicators, data, and methods for rapid field assessments of wetlands and streams. Rapid assessments typically require less than a day to apply at least once, and do not rely on the collection of field materials or any laboratory analysis. Most Level 2 methods are qualitative or semi-quantitative. L2 tools are used to answer monitoring questions about the overall condition or health of individual wetlands and populations of wetlands. They are therefore useful for assessing projects as well as ambient wetland conditions. Key L2 methods for monitoring and assessing wetlands are described below.

Proper Functioning Condition (PFC).

PFC (http://www.blm.gov/or/programs/nrst/pfcassess.php) is a qualitative method for assessing the condition of riparian areas. The term refers to both the assessment process and the condition assessment. PFC provides a consistent approach for considering riparian hydrology, vegetation, and erosion or deposition. PFC assessments indicate how well a riparian area is functioning as a physical system, meaning its resiliency to erosive runoff, instream flow, waves, winds, and land use practices, such as grazing and vegetation management.

California Rapid Assessment Method (CRAM).

CRAM (http://www.cramwetlands.org/). CRAM is a cost-effective rapid assessment method for monitoring the conditions of wetlands and streams. CRAM enables trained practitioners to assess overall wetland health by choosing the best-fit set of narrative descriptions of observable conditions ranging from the worst commonly observed to the best achievable for the type of stream or wetland being assessed. CRAM is supported by a training program with multiple training sessions each year, a statewide database of practitioners and CRAM results (http://www.cramwetlands.org/dataentry) that supports a variety of online data queries and visualizations for CRAM data (http://www.ecoatlas.org/regions/ecoregion/statewide?cram=1).

Level 3 (L3).

Level 3 includes field data to quantify one or more aspects of aquatic resource condition or stress, relative to others aspects, or per unit time or space. L3 data may include any measures of specific ecosystem parameters, including physical, chemical, and biological data. WRAMP requires that L3 data be collected using appropriate procedures and methods, such as the standardized survey protocols used by state and federal wildlife agencies to monitor and assess fish and wildlife habitats and populations, plant community composition, noxious weed surveys, and similar survey protocols.

The Surface Water Ambient Monitoring Program (SWAMP) of the State Water Resources Control Board provides access to many Level 3 methods relating to the water quality of wetlands and streams (http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml). SWAMP has created a Quality Assurance (QA) program, developed standardized data storage system, has created Standard

Operating Procedures (SOPs) for sampling, and continues to create a water quality indictor list. Example SWAMP tools for wetland monitoring include the following.

There are numerous L3 methods being used to assess aquatic resources in California. Most of these methods are site-specific, project-specific, or program-specific. Site- and project-specificity is due in part methodological adjustments for local conditions as needed to control the sampling variance in the L3 data. Program-specificity evolves from efforts to tailor methods to programmatic missions. L3 methods to assess biological parameters tend to be more site- or project-specific than methods to assess physical parameters, and therefore less broadly applicable. Some key L3 methods that have been shown to be broadly applicable in Californian are briefly described below.

USGS Steam Gauging.

The USGS uses continuous water quality monitors to assess water temperature, specific conductance, dissolved oxygen, pH, and water stage height at stations throughout the US. USGS provides standard procedures for station operation (http://pubs.usgs.gov/tm/2006/tm1D3/pdf/TM1D3.pdf). The monitors also can be configured to measure other properties, such as turbidity or fluorescence. Data from sensors can be used in conjunction with chemical analyses of samples to estimate chemical loads.

CDFW Stream Gauging

CDFW has produced its own Standard Operating Procedure for Discharge Measurements in Wadeable Streams in California (http://www.dfg.ca.gov/water/instream_flow.html). The CDFW Instream Flow Program (IFP) was developed to determine what instream flows are needed to maintain healthy conditions for fish and wildlife. The IFP develops information on the relationships between instream flow and available stream habitat to determine if instream flows are adequate, and to prescribe appropriate instream flows when warranted.

NOAA Tide Gauging

The Center for Operational Oceanographic Products and Services (CO-OPS) of NOAA manages the National Water Level Observation Network (NWLON) of approximately 200 continuously operating marine and estuarine water level observation stations in the US coastal zone. NOAA provides specifications and deliverables for installation, operation, and removal of its tide level recorders (http://tidesandcurrents.noaa.gov/publications/CO-OPS_Specifications_and_Deliverables_for_installation_operation_and_removal_of_water_level_stations_updated_November2008.pdf).

USFS Stream channel reference sites.

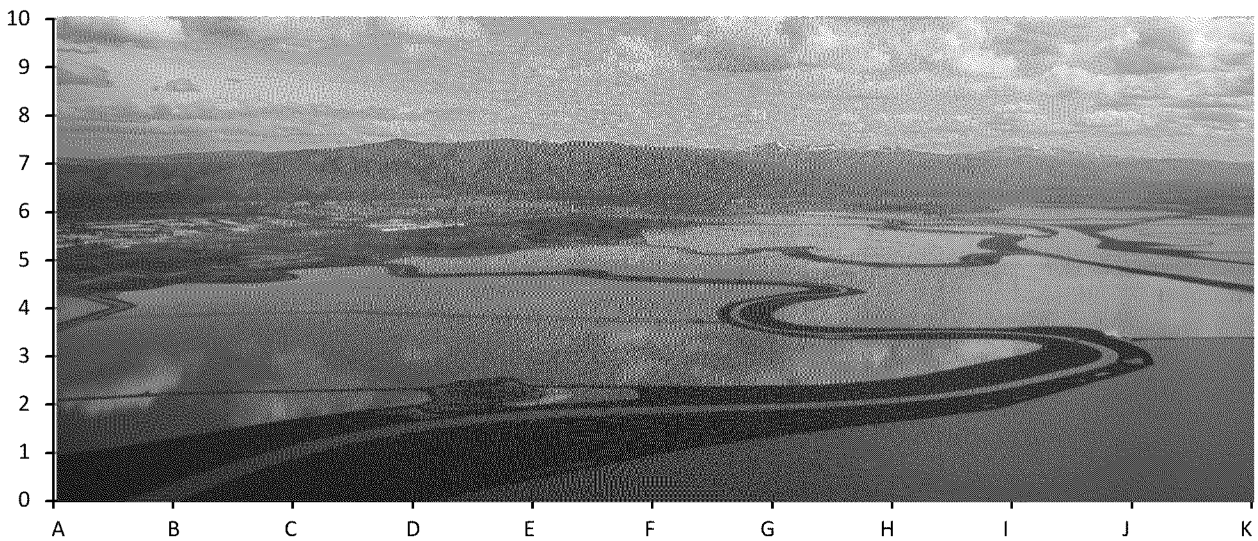
The USFS has published standard hydro-geomorphic methods to assess fluvial channels (http://www.fs.fed.us/rm/pubs_rm/rm_gtr245.pdf). The methods cover the gathering data about the physical characteristics of permanent reference sites for streams and rivers.

Depressional Wetlands MacroinvertebrateSOP.

The Surface Water Ambient Monitoring Program (SWAMP) of the State Water Board provides Standard Operating Procedures (SOP) for the Collection of macroinvertebartes, benthic algae, and associated physical habitat data in California depressional wetlands (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/tools/swamp_wetlands_sop.pdf).

California Stream Condition Index (CSCI).

The CSCI is a biological index of stream health that can be used to compare the observed local conditions of wadeable streams and the regional, least-stressed condition of comparable streams based on benthic macro-invertebrate community structure CSCI http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/docs/csci_tech_memo.pdf).



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Appendix 2: Description of Wildlife Conservation Tools

Introduction

No tools have been developed to specifically support standardized planning, tracking, or assessment of NCCPs and HCPs throughout California. HabiTrak[32] is a tool developed by the San Diego Association of Governments (SANDAG) in cooperation with CDFW and USFWS for viewing and reporting HCP and NCCP implementation efforts in the San Diego area; it has not been applied to other regions of the state. However, CDFW has been developing a variety of tools focused on wildlife conservation that could be combined with the WRAMP tools through the WRAMPw framework to create a robust toolset supporting HCPs and NCPs as well as the 404 Permit Program and the 401 Certification Program. The following descriptions of the wildlife conservation tools are sufficiently detailed to help determine how they might by combined with the WRAMP tools, as guided by the WRAMPw framework.

Vegetation Mapping

Vegetation is often considered to be the best single surrogate for wildlife habitat. Vegetation mapping is therefore playing an increasingly important role in wildlife conservation and management. Vegetation maps comprise one of the three primary components of the common base map for coordinating wildlife conservation and water quality improvement (see Appendix 1).

CALVEG

CALVEG (http://www.fs.fed.us/r5/rsl/projects/classification/system.shtml) is a system of vegetation mapping initiated in 1978 by Region 5 of the USFS. The mission of CALVEG is to map and classify California vegetation communities for regional and statewide natural resource planning and management. The CALVEG classification system conforms to the upper levels of the National Vegetation Classification Standard (USNVC). CALVEG crosswalks easily to cover types of the California Wildlife Habitat Relationships system (CWHR)[33] (Meyer and Laudenslayer 1988 and later versions). Efforts are underway to finalize crosswalks with vegetation types defined in the Manual of California Vegetation.

California Vegetation Classification and Mapping Program (VegCAMP)

VegCAMP (http://www.dfg.ca.gov/biogeodata/vegcamp/) is a system of vegetation mapping developed by CDFW. The purpose of VegCAMP is to complete and maintain maps of all vegetation throughout the state to support local, regional, and statewide natural resource conservation. VegCAMP supports:

- Regional conservation planning;
- Wildlands fire/fuels modeling for improved preparedness;
- Identifying individual plant and animal species distributions;
- Predicting the spread of invasive species;
- Early scoping for transportation projects to minimize impacts;
- Prioritizing land acquisitions for parks and ecological reserves;
- Identifying important wildlife corridors; and
- Setting a baseline for monitoring impacts of global climate change on vegetation.

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[32] https://nrm.dfg.ca.gov/HabiTrak/About.aspx.
[33] https://www.dfg.ca.gov/biogeodata/cwhr/.

Comparison of CALVEG and VegCAMP

Table 1 compares CALVEG and VegCAMP based on basic considerations relating to the use of vegetaion maps as surrogates for maps of wildlife habitat. CALVEG has greater coverage but many fewer vegetation types. The California Fire and Resource Assessment Program (FRAP) maintains a statewide map of vegetation compiled from various sources including CALVEG and VegCAMP that is much less spatially resolute (30m vs 5m) and is therefore not included in this comparison.

Table 1. Comparison of the three vegetation GIS data sets.

Parameter	CALVEG	VegCAMP
Spatial Resolution	5m	5m
Raster or Vector?	Vector (originally raster)	Vector
Extent of Coverage (% of state)	~75% complete (missing Central Coast and Southern interior)	~20% complete (~40% complete or in progress)
Vintage	1997-2014 (varies with region)	2007 to present (varies with region)
Consistent with the FGDC?[34]	Yes	Yes
Crosswalk to CWHR?	Yes	Yes (can also be crosswalked to CALVEG)
Number of vegetation types	~ 200	~ 500

Wildlife and Their Habitats.

Multiple programs of the California Natural Resources Agency continue to develop a variety of tools to track the known locations of state and federally protected species of wildlife, and to predict and visualize the likely distributions of species throughout the state.

California Wildlife Habitat Relationships (CWHR).

CWHR (https://www.dfg.ca.gov/biogeodata/cwhr/) contains information about the life histories, geographic ranges, habitat relationships, and management for 712 species of amphibians, reptiles, birds, and mammals known to occur in California. The purpose of CWHR is to support local, regional, and statewide wildlife conservation.

The present version of CWHR includes 59 wildlife habitat types. These habitat types are incorporated into models that predict wildlife distributions; they do not represent a comprehensive classification of California wildlife habitats. CWHR defines habitat stages for each of the 59 habitat types that are vegetated. A habitat stage is a combination of size class and cover class for tree-dominated habitat types, age and cover class for shrub types, height and cover class for herbaceous types, and depth and substrate for aquatic types. A field sampling protocol is available for determining habitats stages. CWHR also recognizes special habitat elements such as snags, banks and burrows, aquatic features, and forage plant species. The predictive distribution models yield suitability ratings for three habitat functions: breeding, cover (refuge), and feeding. For each species, each habitat stage is rated as high,

[34] The FGDC is the Federal Geographic Data Committee; the Vegetation Subcommittee of the FGDC establishes national vegetation mapping guidelines.

medium, low, or unsuitable for each of these three functions. Each special habitat element is rated as essential, secondarily essential, preferred, or not applicable for each species.

A crosswalk is maintained between CWHR and VegCAMP. However, there is no crosswalk between CWHR aquatic habitat types and any federal or state maps of aquatic resources, including the National Wetland Inventory (NWI) of USFWS, the National Hydrographic Dataset (NHD) of USGS, or the California Aquatic Resources Inventory (CARI) of CWMW. Table 2 provides links to crosswalks between CWHR and other state classifications of land covers.

Table 2. Hyperlinks to crosswalks between CWHR and other California land cover classifications.

CWHR Crosswalked with VegCAMP (2005)
CWHR Crosswalked with CALVEG (2005)
CWHR Crosswalked with DWR Land Use Types (2008)

BIOVIEW accesses CWHW (https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=88643) as a stand-alone application that can be installed on a user's computer. BIOVIEW can be used to download habitat suitability ratings for selected wildlife species for spatial and temporal analyses.

California Natural Diversity Database (CNDDB).

The CNDDB (http://www.dfg.ca.gov/biogeodata/cnddb/) inventories the status and locations of special status plants, animals, and natural communities in California. The goals of the CNDDB are to provide the most current data available on the state's most imperiled wildlife species, and to provide tools to analyze these data. The CNDDB concentrates on areas of the state with active NCCPs and/or HCPs, and high priority areas identified by CDFW and USFWS.

CNDDB is part of a nationwide network of similar programs overseen by Nature Serve (http://www.natureserve.org/). All natural heritage programs include ways to deliver their data and information to the public, other agencies, and conservation organizations. The data help drive conservation decisions, aid in the environmental review of projects and land use changes, and provide baseline data helpful in recovering endangered species and conducting environmental research.

RareFind accesses the CNDDB (http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp), enabling subscribers to query the CNDDB and report field sightings. The database is updated monthly. RareFind 3 is a Windows-based application that can be installed on the user's computer, while RareFind 5 is a newer, Internet-based application that eliminates the need for the user to download updated data.

Comparison between CWHR and CNDDB.

CWHR and CNDDB differ with regard to their content and its origins. CWHR only includes information about terrestrial vertebrates, including those accidentally or intentionally introduced into the state. In contrast, CNDDB includes information on species of plants, fish, invertebrates and natural communities, but only if they are consider by CDFW to meet criteria for "at risk" status (CDFW 2015a,b,c). The contents of CWHR are generated by predictive models, whereas the contents of CNDDB result entirely from empirical field observations.

Additional Data Viewers.

The California Natural Resources Agency recognizes the need to efficiently deliver information about wildlife to local, regional, statewide, and national communities of wildlife conservation interests, including the public. Its departments have therefore developed a variety of web-based information delivery systems.

Areas of Conservation Emphasis Viewer (ACE-II).

ACE-II (http://www.dfg.ca.gov/biogeodata/ace/) is being developed by CDFW to:

- Compile and analyze the best available statewide, spatial information on California's biological richness, including species diversity, rarity, and sensitive habitats;
- Collect information on recreational needs and opportunities throughout the state, including fishing, hunting, and wildlife-viewing;
- Develop a set of tools and produce maps that summarize and display ACE-II content conservation decision-making; and
- Integrate ACE-II content into a spatial model that can be used to identify areas of biological or conservation interest throughout the state.

ACE-II integrates data from other CDFW conservation tools. It is a component of a larger strategy for the conservation and management of California's natural resources at a landscape scale. Other aspects of this plan are represented in Table 3 below.

Table 3. Hyperlinks to componnets of the strategy to conservation and management of California's natural resources.

California Wildlife Conservation Challenges
California Climate Adaptation Strategy
California Essential Habitat Connectivity Project

Biogeographic Information and Observation System (BIOS)

BIOS (http://www.dfg.ca.gov/biogeodata/bios/) has been developed by the Biogeographic Data Branch of CDFW to enable the management, visualization, and analysis of biogeographic data collected by different programs of CDFW and its partner organizations. BIOS integrates GIS, relational database management, and ESRI's ArcGIS Server technology to create a robust, statewide, integrated, online, information management and delivery tool.

HabiTrak

HabiTrak (https://nrm.dfg.ca.gov/HabiTrak/About.aspx) has been developed by the San Diego Association of Governments (SANDAG) in cooperation with CDFW and USFWS for tracking and reporting habitats conserved and lost over time. This tool only applies to San Diego HCP at this time.[35] HabiTrak was initially developed in 1999 as a stand-alone desktop geographic information system for data entry and reporting using ESRI ArcView 3.x. It was redeveloped in 2006 as both a desktop data entry extension for the newer ESRI ArcGIS 9.1, and as a set of web-based reporting and map tools. Each HCP member agency locally enters its maps of habitat changes into ArcGIS using the HabiTrak extension, where they are used to calculate acres of habitat change. Once the maps are processed, reports can be generated using the HabiTrak web-based reporting interface. When an agency has indicated its data are final, they are incorporated into the CDFW statewide database for habitat tracking, and made available to the public through the online map viewer.

[35] Personal communication with Diane Mastalir, GIS Specialist, Habitat Conservation Planning Branch, CDFW.

Appendix 3: Concept of an Integrated Landscape Condition Report

Introduction

Coordinated monitoring and assessment for wildlife conservation and water quality improvement in the landscape context provides an opportunity to synthesize a public report on overall landscape condition. The purpose of an Integrated Landscape Condition Report is to provide a single, repeatable, succinct overview of progress toward environmental goals and objectives. With regard to wildlife conservation and water quality improvement, the report might focus on effectiveness and compliance for HCPs, NCCPs, 404 permits, 401 Certifications, and WDRs. Such a report could be expanded to address aquatic resource protection more generally by adding in stormwater management, flood control, water supply management, and aquatic recreation.

It is unlikely that a single integrated report, no matter how comprehensive, can replace the individual monitoring reports legally required by the various environmental permits for any given landscape. However, the overall cumulative effect of the permitted actions can be synthesized for the landscape as a whole. The synthesis can focus on the results of all ambient monitoring within the landscape as well as summary statistics on compliance. For an HCP or NCCP, compliance can be summarized as the numbers of acres of targeted habitats that have been protected or restored, and the overall conditions of the habitats. For an HCP, NCCP, and for the 404 and 401-WDR Programs, the report might also summarize project compliance, using metrics such as the percent of projects meeting their scheduled performance criteria.

Assuming that condition is assessed relative to target conditions (i.e., goals and objectives for wildlife conservation and water quality improvement), and assuming that the targets in aggregate represent good health, the report might feature a Landscape Health Report Card. This could be a simple graph of the status of the landscape with regard to each condition metric for each category of condition, and for the landscape as a whole (see Figure 1 below). To produce the Health Report Card, the metrics are arrayed by name along the x-axis, and their numeric values are plotted as the percentages of their target values. The area between the top of a bar and the top of the graph represents a gap in health (i.e., the needed improvement in condition to achieve the target health status). The sum total of the areas of all the bars, as a percent of the total area of the graph, represents the overall health status for the landscape. It is assumed that the target values in aggregate represent the best achievable condition for the aspects of health represented by the metrics.

Wildlife and water quality managers can use a Landscape Health Report Card to commonly identify critical data gaps and to help prioritize management actions. For example, the managers might focus on establishing targets where they are needed, adjusting the targets for new understanding or changing circumstances, shifting the monitoring focus to where it is most needed, and implementing projects to improve habitats for which targets exist and conditions are especially low. The Health Report Card could be delivered through any number of websites to improve inter-agency coordination and public communication.

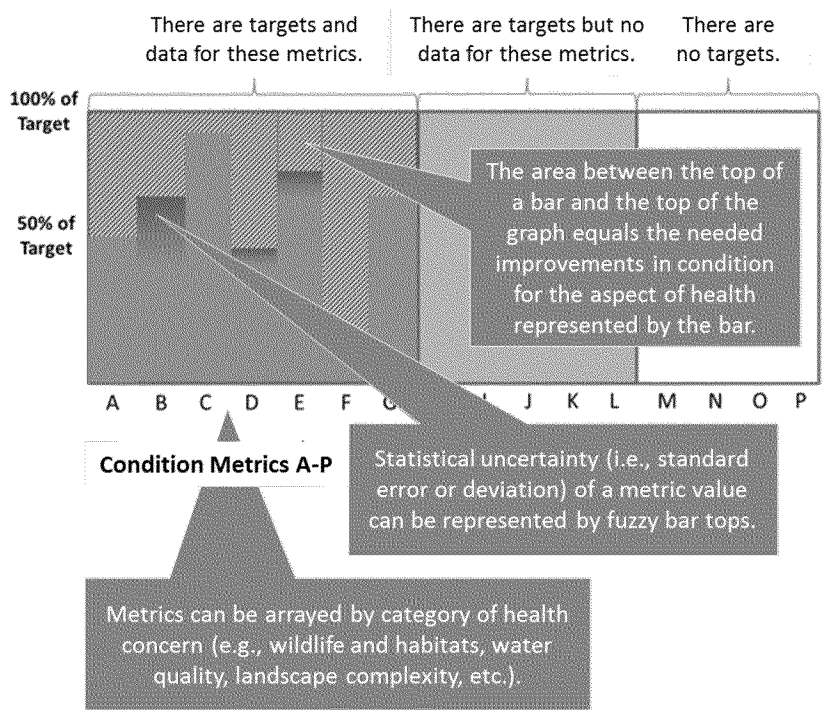
Many similar approaches have been used to develop summary assessments of environmental condition or the performance of environmental programs (e.g., Rapport 1989, USEPA 1992, Heinz Center 2008, and CBF 2012). This particular approach was selected by the San Francisco Estuary Partnership for integrating different kinds of information about the ecological health of the Bay-Delta ecosystem (SFEP 2015). It is also being considered by the Santa Clara Valley Water District[36] and the North Coast

[36] Personal communication, Norma Camacho, Chief Operating Officer, Watersheds Operations, San at Clara Valley Water District.

Regional Water Board [37] as the framework for reporting on local watershed condition. There are many advantages to this approach to summarizing environmental health, some of which are listed below.

- This approach is applicable to any spatial scale or time period for which the metrics can be evaluated. For example, it could be applied to one or more landscapes of any size, as well as to individual or multiple on-the-ground projects.
- There is no limit to the number of aspects of health that can be represented, assuming numerical objectives for them have been established, useful metrics have been developed, and there are adequate data for the metrics to assess status.
- Metrics can be grouped together as desired. For example, metrics might be grouped by habitat type, contaminant type, time period, program, etc.
- Individual metrics or groups of them can be weighted for their relative importance by widening or narrowing their respective bars.
- The uncertainty of metric values (e.g., their statistical error) can be translated into a range of values of known precision, or the uncertainty can be represented graphically as error bars or shading of the bar tops.
- The effect of changes in targets on health condition can be explored, and past evaluations can be revised for changes in targets.
- The health report card can be easily shared with the public and mass media.
- If warranted, the health report card can be linked to the databases for the metrics and automated. It can also be interactive, such that online viewers can access documentation of assessment methods and supporting data directly through the graph. Ideally, the report would be used to prioritize future management actions, and to report their performance to the public.

***Figure 1**: Schematic diagram of the concept of a Landscape Health Report Card.*



[37] Personal communication, Shin-Roei Lee, Deputy Executive Officer, North Coast Regional Water Quality Control Board.

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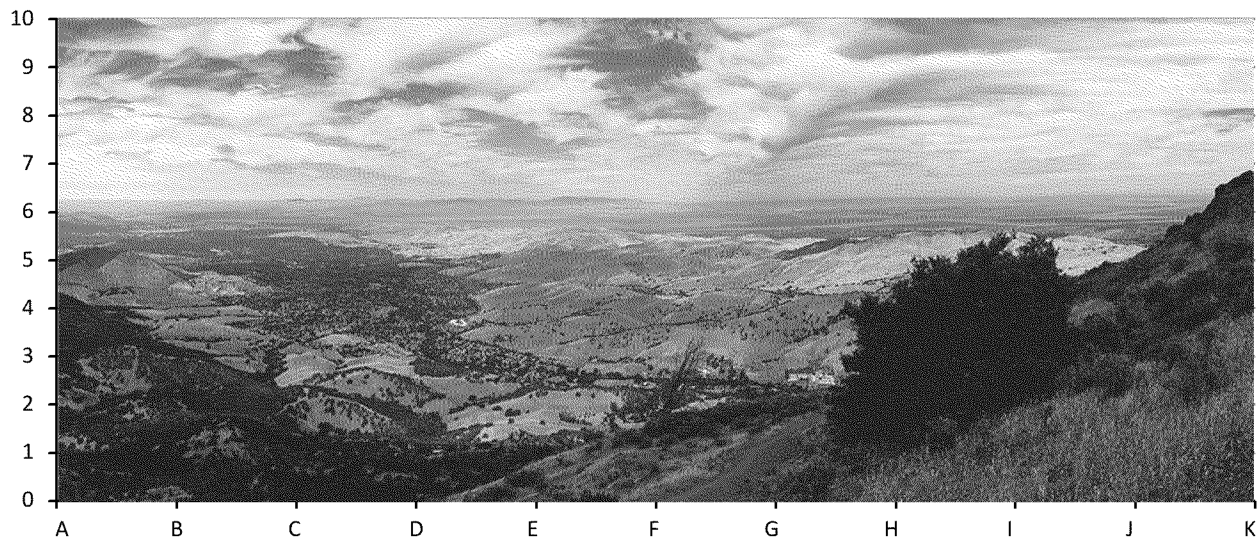

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Appendix 4: Application of the WRAMP Toolset to the East Contra Costa County HCP/NCCP

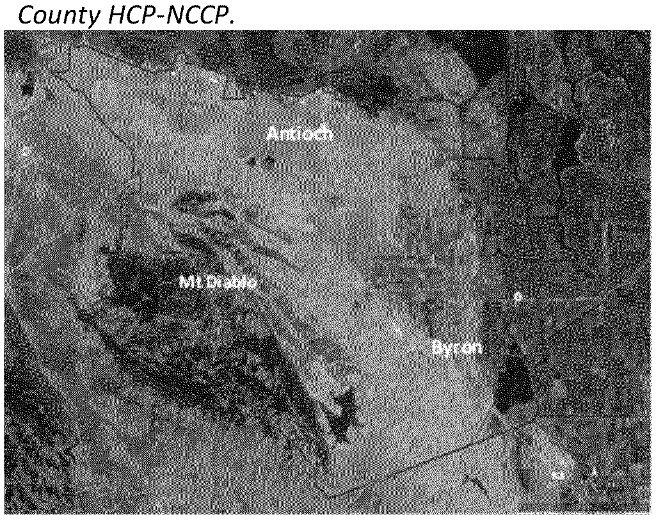
Introduction

This case study illustrates how the proposed framework can help coordinate uses of the WRAMP toolset and the wildlife conservation toolset (Appendices 1 and 2 above) to implement the landscape approach to wildlife conservation and water quality improvement. The focus is on aquatic resource monitoring, assessment, and reporting through the federal habitat Conservation Plans (HCPs) of the USFWS, state Natural Community Conservation Plans (NCCPs) of the CDFW, federal Dredge and Fill Permits (404 Program) of USACE and USEPA, and the state Dredge and Fill Permit Certification and Waste Discharge Requirements (401-WDR Program) of the State Water Board. The framework and toolsets can also be used to coordinate planning of these and other environmental programs and projects in the landscape context, including but not limited to timber harvest, stormwater management, and flood control. The emphasis here, however, is on monitoring, assessment, and reporting for aquatic resources.

The East Contra Costa County HCP-NCCP[38] was selected as the case study because of its relative newness, readily accessible plans and reports, and the availability of data, including maps of historical habitat types. Each HCP and NCCP is unique in many regards, due in part to differences in physical geography, covered species and habitat types, land use types and governance, and social and institutional culture[39]. The ECCCHCP-NCCP (the Plan) is a reasonable representation of large-scale, multi-species, wildlife conservation plan.

Overview of the Plan

Figure 1. *Boundary of the East Contra Costa County HCP-NCCP.*



The Plan was approved in 2006. It covers about 174,000 acres in East Contra Costa County south and east of the Sacramento and San Joaquin Rivers (Figure 1), including multiple municipalities. It is administered by the East Contra Costa County Habitat Conservancy (ECCCHC). The Plan provides 30-yr agreements to permit incidental take[40] of plant and animal species covered by the U.S. Endangered Species Act (ESA) and/or the state's Natural Community Conservation Planning Act (NCCPA).

The Plan is designed to accommodate reasonable and expected human population growth over the next 30 years.

Total area of impacts allowed under the Plan ranges from 9,796 acres to 13,029 acres, based on the initial and maximum projected urban

[38] http://www.co.contra-costa.ca.us/depart/cd/water/HCP/.

[39] Personal communication: Jennifer Norris, Field Supervisor, Sacramento Field Office, USFWS; and Brenda Johnson, Program Manager, Conservation Planning, Habitat Conservation Planning Branch, CDFW.

[40] Take is defined by the U.S. Endangered Species Act (ESA) as any conduct to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Take is defined under the California Fish and Game Code as any action or attempt to "hunt, pursue, catch, capture, or kill." In the 1982 ESA amendments, Congress authorized the U.S. Fish and Wildlife Service (USFWS) to issue permits for the "incidental take" of endangered and threatened wildlife species.

development areas, respectively. To offset these impacts, the Plan contains a total of 33 biological goals and 91 biological objectives for 28 covered species. The goals and objectives have been summarized as follows:

- Manage habitats to enhance populations of covered species and maintain ecosystem processes;
- Preserve habitat connections linking existing and future protected private and public lands;
- Preserve approximately 23,800 acres of land under the initial urban development area (range = 21,450–27,050 acres) or approximately 30,300 acres of land under the maximum urban development area (range = 26,050– 34,350 acres) for the benefit of covered species, natural communities, biological diversity, and ecosystem function;
- To achieve no net loss of jurisdictional wetlands and waters, and to contribute to the recovery of certain species, the Plan requires not only calls for habitat preservation but also compensatory mitigation for permitted habitat impacts, as well as additional habitat restoration. Although the exact acreage is not known, total future restoration is estimated at 436 to 598 acres under the initial and maximum urban development scenarios. The target habitat types are:
    - Grassland, including native grassland;
    - Oak woodland and oak savanna;
    - Wetlands and ponds;
    - Streams and riparian woodland; and
    - Chaparral/scrub.

Two of these five habitat types, wetlands and streams, serve as a clear nexus between the Plan and water quality improvement.

The Plan outlines an adaptive management program that includes compliance and effectiveness monitoring as required under ESA and NCCPA. The effectiveness monitoring is intended to focus on three subjects:

- Landscapes, communities, and species ECCHCP-NCCP Preserve System;
- Overall ecosystem function; and
- Overall status of covered species.

All three of these focus areas have a nexus with water quality improvement, given that one of the objectives of both the 404 Program and the 401-WDR Program is to protect the natural processes that sustain the integrity and beneficial uses of federal and state waters.

The current version of the Plan precededboth the WRAMP framework and WRAMPw framework. However, the process used to develop the Plan is generally consistent with the steps of the proposed framework. The stepwise framework can therfeiore be used to assess consistency between it and the Plan. The translation recognizes synonomies in terminology. In fact, one clearly needed component of a coordinated assessment and monitoring for wildlife conservation and water quality improvement is a common technical lexicon for many basic monitoring terms, such as indicator, metric, sample frame, etc. Table 1 below indicates the degree to which the Plan is consistent with each Step of this framework.

***Table 1**: Summary of the analysis of consistency between the East Contra Costa County HCP-NCCP (Plan), 2014 Annual Report of the Plan[41], and the ten steps of the proposed version of the WRAMPw framework.*

WRAMPw **Step**	**ECCHCP-NCCP Consistency** High Medium Low
Step 1 (Driving Concersn)	Driving Concerns were identified as the reasons for its devlopment.
Step 2 (Conceptual Models for Monitoring Questions)	The habitat requirements of 20 of the 28 covered species were modeled, translated into species profiles, and used to formulate biological goals and objectives.
Step 3 (Monitoring Questions)	Overall biological goals and objectives and performance criteria for individual restoration projects are developed but not translated into monitoring questions. The questions could be inferred from the indicators and performance criteria but this reverses the WRAMPw steps and may yield more indicators than necessary.
Step 4 (Conceptual Models for Data Needs)	These models are called for in the Plan and are being developed as the monitoring and assessment program evolves.
Step 5 (Data Needs)	The plan provides a set of principles and other considerations for planning a monitoring program largely consistent with WRAMPw, although the USEPA 3-Level framework is not utilized. The base map is dated and lacking key data for wildlife habitats. A unique habitat classification system prevents leverages state and federal map data and tools.
Steps 6 and 7 (Landscape Scenario Planning and Preferred Profile)	The ECCHCP-NCCP employed a combination of map-based and purely qualitative approaches. Maps were used to display conservation priorities but not to generate them. The plan did not quantitatively assess alternative landscapes except in terms of acreages, and relied instead on discussion of the relative merits of the alternatives based on best professional judgement. Unless additional spatial metrics emerge through the monitoring design, the only habitat parameter to assess compliance or effectiveness will be habitat acreage. The general location, size, and configuration of habitat types of the preserves are included in the preserve acquisition conservation measure, and could be quantified as the preferred landscape profile, but it has not been quantified by any metric other than habitat acreage.
Step 8 (Monitoring and Assessment)	The Plan provides guidance for developing a monitoring program through implementation of the Plan. The emerging program is partially consistent with the WRAMPw framework. It employs a comparable stepwise pathway to indicators of condition involving conceptual modeling, sampling plans, and indicator interpretation; it involves tracking acres of impacts and conservation actions as well as the performance of restoration actions. However, it does not define monitoring questions (Step 3) or employ the USEPA 3-level system to define data needs (Step 5).
Step 9 (Data Management and Reporting)	The Plan calls for a database and clear reporting procedure linked to a GIS, and recommends HabiTrak[42] or a compatible information delivery system, but does not actually provide the procedures or outline the needed system. To date, the data and GIS are not easily accessible outside the ECCCHC. The annual report does not summarize condition across the Plan relative to its goals and objectives nor to the performance criteria of local restoration or mitigation projects.
Step 10 (revisit Driving Concerns)	HCPs, NCCPs, and the ECCHCP-NCCP do not identify alteration of the biological goals and objectives as part of adaptive management. Acording to this framework, such adjustments may be mandated by changes in scientific understanding and external forces including economic and climatic change.

[41] http://www.co.contra-costa.ca.us/depart/cd/water/HCP/news/2014_ECCCHC_AnnualReport_Combined_web.pdf.
[42] https://nrm.dfg.ca.gov/HabiTrak/.

Using WRAMP and Wildlife Conservation Toolsets to Coordinate Monitoring and Assessment

The WRAMP toolset and the wildlife conservation toolset (see Appendices 1 and 2 above) can be us43d together to improve monitoring, assessment, and reporting for aquatic resources under HCP, NCCP, the 404 Program, and the 401-WDR Program. In essence, the wildlife conservation tools can be applied according to the proposed WRAMPw framework.

The emphasis in this section of the case study is on coordinated use of the standardized WRAMP tools and the wildlife conservation tools to define and meet data needs (Step 5 of the framework), conduct landscape scenario planning (Step 6), select a preferred profile (Step 7), monitor and assess conditions, (Step 8), manage data and report status and trends (Step 9), and review the goals and objectives of the Plan (Step 10).

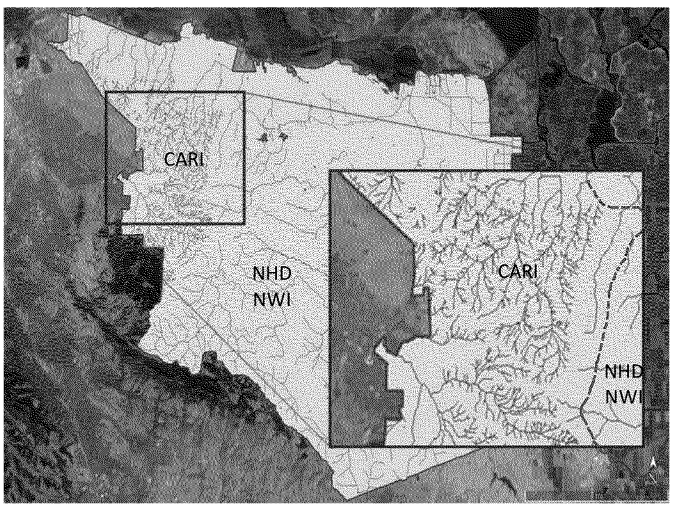
Conceptual modeling (Steps 2 and 4) is not addressed in this case study. Conceptual can be considered as technical tools (Odum 1983, Jackson et al. 2000, Hale 2003, Heemskerk et al. 2003). However, different models are needed to account for natural differences among landscapes and their different management goals and objectives. While the general approach to conceptual modeling can be standardized (see descriptions of framework Steps 2 and 4), there is no standard set of detailed models that work equally well among all landscapes.

Primary Data Needs

<u>*Base Map Production (Framework Step 5)*</u>

A base map of surface water, vegetation, and topography that commonly serves all interests in water quality improvement and wildlife conservation is the single most important technical tool for their coordination. The purpose of the base map is to accurately portray the natural infrastructure and environmental context of landscape management actions. The base map must encompass the entire landscape or watershed of interest and indicate its boundary (see Figure 1 above).

Figure 3: Illustration of the variability of CARI within the area of the Plan. The enlargement shows the area of the Plan where the CARI SOP has been implemented.



Unless existing maps of surface waters are adequate, additional mapping based on the CARI SOP may be necessary. For example, CARI varies markedly in detail across the Plan area. The detail is much greater for the eastern portion of the area, where the CARI SOP has been implemented (Figure 3). The remainder of the map of surface waters consists of NHD and NWI of varying vintage. It should be noted that any errors or omissions in the map of surface waters can be corrected using the online CARI editor tool. Local corrections can be made on an as-needed basis, such that the map is improved over time. This map is quantified later in the Appendix as part of the Landscape Profile.

Criteria have been drafted for designing and evaluating a base map. These criteria can be used to select primary datasets and their sources (see Table 2 below).

Table 2: Criteria for designing and evaluating digital base maps for implementing the proposed framework. The criteria are ranked in order of general importance (the criterion of greatest importance is ranked #1).

<table>
<tr><th>Category</th><th>Rank</th><th colspan="2">Criteria</th><th>Sources of Data and Methodology</th></tr>
<tr><td rowspan="4">Content</td><td>1</td><td colspan="2">• Incorporates the entire geographic scope of the area of interest in one seamless map.</td><td>HCP-NCCP implementing entity</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">• Includes these three data layers that comprise the basic content.</td><td>• Topography</td><td>USGS 2016a</td></tr>
<tr><td>• Surface Waters</td><td>USGS 2016b, USFWS 2016, CWMW 2016</td></tr>
<tr><td>3</td><td>• Portrays all the specific categories or classes of topography, surface waters, and vascular vegetation necessary to represent the related natural processes effecting key conditions according to the conceptual models.</td><td>• Vegetation</td><td>Sawyer et al. 2009, USFS 2016</td></tr>
<tr><td>Accuracy</td><td>4</td><td colspan="2">• The accuracy of the maps of topography, surface waters, and vascular vegetation are deemed adequate by all governmental programs responsible for wildlife conservation or water quality improvement.</td><td rowspan="6">Base map Technical Advisory Committee

Expert review of the base map by its users is a key aspect of its development. The experts should be assembled from the community of base map users as a technical advisory committee. The base map TAC will need to advise the initial and ongoing development of the base map.</td></tr>
<tr><td rowspan="2">Usability</td><td>5</td><td colspan="2">• Can be shared through web services and thereby posted on any number of websites used to visualize environmental conditions within the geographic scope of the map.</td></tr>
<tr><td>6</td><td colspan="2">• Can be edited online by its user community, given appropriate assurances of security and quality control.</td></tr>
<tr><td rowspan="3">Conformity*</td><td>7</td><td colspan="2">• Incorporates existing data layers produced or vetted by federal, state, regional, or local agencies.</td></tr>
<tr><td>8</td><td colspan="2">• Complies with federal and state mapping standards for topography, surface waters, and vascular vegetation.</td></tr>
<tr><td>9</td><td colspan="2">• Is consistent with other mapping efforts by government agencies operating within the geographic scope of the map. For example, overlaying federal, state, and local data for infrastructure, land use, and environmental conditions should be readily doable.</td></tr>
<tr><td colspan="5">* The importance of conformity can increase with state and federal partnership; the abundance of overlaying state, federal and regional datasets; and the geographic scope of the base map.</td></tr>
</table>

Common Additional Level 1 (L1) Data

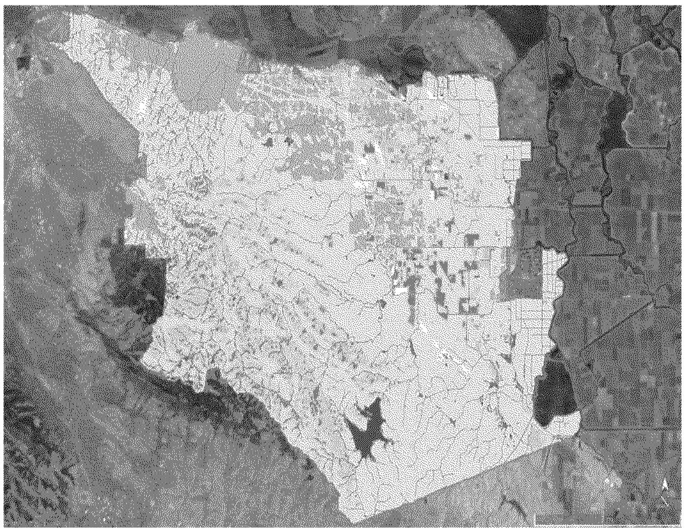
Aerial Imagery

Displaying the base map on high-resolution aerial imagery can be essential for maximizing its interpretive and communications value. The primary statewide source of suitable imagery is the National Aerial Imagery Program NAIP (USDA 2016).

It is technically possible to upload any or all digital elements of the base map into Google Earth. Using Google earth to display the base map can greatly increase its public access while also providing the display functions of Google Earth, including 3D rotation. However, uploading data into Google Earth relinquishes some control on the use of the data and where it resides. Furthermore, there are legal limitations on the reuse or distribution of products created through Google Earth using uploaded public or private data (https://www.google.com/help/legalnotices_maps.html). As discussed below, the EcoAtlas provides ways for data authors including government agencies to display base maps and other data without relinquishing control on its management or usage.

Wildlife Habitat Relationships

Figure 3: Map of key terrestrial and aquatic habitats identified in the Plan, as derived from WHR and CARI.



With regard to wildlife conservation, the maps of vegetation and surface waters are especially valuable. They can serve as proxies for maps of terrestrial, riparian, and aquatic habitat types. To help maximize the ecological meaning of vegetation maps, the CDFW and USFS have created crosswalks between the California Wildlife Habitat Relations (CWHR) system (CDFW 2016) and both the CALVEG and VegCAMP systems for classifying vegetation. Since VegCAMP does not exist for the entire area of the Plan, CALVEG was used to map CWHR (Figure 3). The resultant map can be quantified to assess the absolute and relative abundances of the priority habitat types.

Indicators of Compliance and Effectiveness

The Plan does not prescribe a complete monitoring assessment program for aquatic resources. It recognizes that many details about monitoring and assessment will need to be developed over time. It therefore outlines a program and provides guidance for plan development. The outline recognizes the need to assess conditions at multiple spatial and temporal scales, and it suggests indicators of condition that could be used in the monitoring program. For some indicators, the Plan also provides example targets or performance standards. The management objectives, suggested indicators, and related targets identified or strongly implied in the Plan are summarized below (Tables 3A-C), based on the 3-level system of data classification featured at Step 5 of the proposed framework. As appropriate, additional indicators are suggested to fill possible data gaps.

Table 3A: Suggested wildlife conservation indicators based on the Plan and the proposed framework: ***native communities and species.***

Provided or implied by the Plan | Suggested from WRAMP | Provided or implied by Plan but could be exchanged for lower WRAMP level indicator, or is a stressor indicator

Management Concern	Indicator	WRAMPw Level	Target Condition or Performance Standard
Stock Ponds	CRAM	2	CRAM Index score > 80.
	Presence/absence nonnative fish and frogs	3	No nonnative fish (except mosquitofish) or bullfrogs.
	Plant species relative % cover	3	__% Native emergent vegetation along at least __% of pond edge.
Alkali Wetlands	Acres mapped from aerial imagery or LiDar.	1	15 Acres restored
	CRAM	2	CRAM Index score > 80.
	Plant species relative % cover	3	__% Relative native alkali wetland plant cover
	Plant species richness	3	__% Native plant diversity
Seasonal Wetlands	Acres mapped from aerial imagery or LiDar.	1	45 Acres restored
	CRAM	2	CRAM Index score > 80.
	Plant species relative % cover	3	__% Relative native seasonal wetland plant cover
	Plant species richness	3	__% Reference native plant species diversity
Created Ponds	Acres mapped from aerial imagery or LiDar.	1	13 Acres created.
	CRAM	2	CRAM Index score > 80.
	Plant species relative % cover	3	__% Of ponds will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) for at least 50% of surface area.
	Plant species relative % cover	3	__% Of ponds that support emergent vegetation over at least 30% but no more than __% of the surface area.
			__% Of each pond margin has at least __% native emergent vegetation.
	Presence/absence nonnative fish and frogs	3	No nonnative fish (except mosquitofish) or bullfrogs.
Perennial Wetlands	Acres mapped from aerial imagery or LiDar.	1	32 Acres
	CRAM	2	CRAM Index score > 80.
	Plant species relative % cover	3	__% Of ponds will support emergent vegetation over at least 30% but no more than __% of the surface area.
		3	__% Relative native seasonal wetland plant cover.
	Presence/absence nonnative fish and frogs	3	No nonnative fish (except mosquitofish) or bullfrogs.
	Visual inspection	2	No desiccation during dry years

Table 3A Continued: Suggested wildlife conservation indicators based on the Plan and the proposed framework: ***Native Communities and Species.***

Provided or implied by the Plan | Suggested from WRAMP | Provided or implied by Plan but could be exchanged for lower WRAMP level indicator, or is a stressor indicator

Management Concern	Indicator	WRAMPw Level	Target Condition or Performance Standard
Mitigate Loss of Giant Garter Snake Habitat	See monitoring suggestions elsewhere in Tables 3A and 3B for wetlands and streams.		
Mitigate Loss of Shrimp Habitat	Acres mapped from aerial imagery or LiDar.	1	2:1 Mitigation ratio (acres)
	This stressor should not be monitored unless habitat is chronically unoccupied.		Maintain pooled surface water in normal rainfall years similar in duration to reference sites within preserves
	"A" values for CRAM Biological Attribute metrics	2	Self-sustaining populations of native vernal pool plants are maintained.
	Probabilistic survey of covered shrimp presence/absence among population of pools	3	Self-sustaining populations of covered shrimp affected by covered activities are maintained
Manage Streams and Riparian Woodland/Scrub	Acres mapped from aerial imagery or LiDar.	1	__% Increase in relative native tree canopy cover.
		1	__% Increase in relative native shrub canopy cover.
	Cumulative frequency distribution of riparian functional width using RipZET.	1	__ More miles of full-function riparian width.
Mitigate Loss of Streams and Riparian Woodland/Scrub	Acres mapped from aerial imagery or LiDar.	1	1 Acre
	Miles of riparian functional width using RipZET.	1	__% relative native tree canopy cover established.
		1	__% relative native shrub canopy cover established.

Table 3B: Suggested indicators based on the Plan and the proposed framework: ***water quality.***[43]

Provided or implied by the Plan	Suggested from WRAMP or SWAMP	Provided or implied by Plan but could be exchanged for lower WRAMP level indicator, or is a stressor indicator	
Management Concerns	**Indicator**	**WRAMPw Level**	**Target Condition or Performance Standard**
Are conditions in local watersheds protecting the beneficial uses of receiving waters?	Existing Landscape Profile (i.e., the current distribution, abundance, diversity and condition of aquatic resources)	1, 2	Preferred Landscape Profile (i.e., ideal distribution, abundance, diversity condition of aquatic habitat types).
	Probabilistic surveys of stream condition using Indices of Biological Integrity (IBIs), the Stream Condition Index, and CRAM.	2, 3	Scores are comparable to reference conditions.
Do mercury loads in Marsh Creek exceed the Total Maximum Daily Load (TMDL)?	Mercury concentrations in sentinel species.	3	Mean MeHg concentration ≤ 0.08 and 0.24 mg/kg wet tissue weight of trophic level 3 and 4 fish, respectively, and ≤ 0.03 mg/kg in whole fish < 50 mm in length.
	Mercury concentrations in storm runoff.	3	Total Mercury in streams ≤ 2.1 µg/L.
		3	73% reduction in Marsh Creek load to the Delta.
For contaminants other than mercury, are numeric and narrative water quality objectives being met in local streams?	Standard methods of data collection and analysis for each analyte.	3	Numeric or narrative objectives of the relevant Regional Water Board Basin Plan are not exceeded.[44]

[43] Evidence of water quality concerns for the landscapes covered by the Plan has been compiled from the following sources:

- Surface Water Ambient Monitoring Program (SWAMP), State Water Board, http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml.
- Cleanup and Abatement Order R5-2013-0701, Central Valley Water Quality Control Board, http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/contra_costa/r5-2014-0124_cao.pdf.
- Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury Staff Report, Central Valley Water Quality Control Board http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_tmdl_staffrpt_final.pdf.
- Dutch Slough Tidal Marsh Restoration Project Final Environmental Impact Report, CA Department of Water Resources and State Coastal Conservancy, http://water.ca.gov/floodsafe/fessro/environmental/dee/docs/DS_FinalSEIR_FullDoc.pdf.
- Integrated Monitoring Report, Water Years 2012 and 2013, Contra Costa Clean Water Program: http://www.waterboards.ca.gov/rwqcb2/water_issues/programs/stormwater/Municipal/IMR/CC_Countywide_A_2014.pdf.

[44] Numeric and narrative objectives and related monitoring methods are too numerous to include here and are available through the Regional Water Boards.

Table 3C: Suggested wildlife conservation indicators based on the Plan and the proposed framework: ***Landscapes.***

Provided or implied by the Plan	Suggested from WRAMP	Provided or implied by Plan but could be exchanged for lower WRAMP level indicator, or is a stressor indicator	
Management Concern	**Indicator**	**WRAMPw Level**	**Target Condition or Performance Standard**
Abundances of wetlands, ponds, streams, and riparian areas within the preserve system	Existing Landscape Profile (i.e., the current distribution, abundance, diversity and condition of aquatic resources)	1	Preferred Landscape Profile (i.e., distribution, abundance, diversity and condition of aquatic habitat types).
Changes in habitat that result from management activities.	Temporal difference in distribution, abundance, diversity and/or condition of aquatic resources.	1	Increased similarity between existing and preferred landscape profile.
Trends in wetland condition especially regarding vegetation within preserve system.	Temporal difference in scores for the CRAM biological structure metrics.	1	Increased scores for CRAM biological structure metrics.
Priority wetlands and ponds for restoration and enhancement.	CRAM index scores for candidate sites relative to existing landscape profile of wetland condition. Effect of candidate sites on wetland connectivity.	1	Regular updates in clearly defined priority sites.
Wetland and pond capacity and hydroperiod.	*This stressor should not be monitored unless habitat condition is otherwise found inadequate.*		
Priority stream and riparian corridors within the preserve system for enhancement or restoration.	CRAM index scores for sites relative to existing landscape profile of stream condition. RipZET scores for incision, riparian functional width, and floodplain connectivity.	1	Regular updates in clearly defined priority sites.
Effect of flooding on stream ecosystems.	*This stressor should not be monitored unless habitat condition is otherwise found inadequate.*		
Connectivity of riparian corridors.	Riparian corridor length by width class based on RipZET.	1	Increased length of riparian corridors with full function length.
Connectivity among aquatic habitat types and between them and terrestrial habitat types.	Cumulative frequency distributions of Inter-habitat patch distance and habitat patch size-frequency calculated from the base map for target areas.	1	Decreased distance between the same and different wetland types. Decreased distance between healthy aquatic and terrestrial habitat patches.
The delineation and function of watersheds.	Watershed maps based on EcoAtlas delineator. Quantitative metrics of the preferred Landscape Profile of each target watershed.	1	Compatible watershed management goals for flood control, water supply, water quality improvement, aquatic recreation, and wildlife conservation.

Tables 3A-C above suggest that applications of the proposed framework can lead to fundamental adjustments in the monitoring program outlined in the Plan. These adjustments are expected to reduce the costs of monitoring and assessment.

- For monitoring landscapes and natural communities, develop and update a base map of aquatic and terrestrial habitats that can be used to calculate Level 1 metrics, such as habitat extent, diversity, patch size-frequency, and connectivity. These metrics can be used to assess landscape change due to either wildlife conservation or water quality improvement.
- For monitoring habitat types, consider probabilistic surveys using cost-effective Level 2 indicators, such as the Stream Condition Index, Proper Functional Condition, or CRAM.
- For monitoring target species, consider substituting measures of presence-absence for estimates of population size, using probabilistic surveys of effective habitats.
- For water quality monitoring, consider using surveys of sentinel species near to suspected contaminant sources.
- Focus on monitoring condition and not stress; avoid assessing stressors except to explore causes of conditions that the monitoring data have shown to be unacceptable. Simply stated, don't monitor causes of conditions that have not been determined

There is a general assumption that improvements in the landscape profile for aquatic resources, such as increases in aquatic habitat patch size, diversity of habitat types, width and length of riparian areas, connectivity among patches, and overall habitat structural complexity will benefit water quality as well and wildlife (USEPA 1996, Thomas and Lamb 2005, USACE and USEPA 2008, Hruby et al. 2009, Sumner et al. 2010, ELI and TNC 2014). This may not always be true for some contaminants or species, however. For example, environmental mercury can be methylated under some wetland conditions and thereby become more biologically dangerous (Zillioux et al. 1993, Hurley 1995, Ackerman et al. 2006, Henneberry et al. 2013). Increases in connectivity between aquatic areas and either agriculture or urban development can greatly increase runoff, causing an imbalance between inputs of water and sediment to stream systems that in turn causes them to either aggrade or incise (Dunne and Leopold 1978, USEPA 1987, Center for Watershed Protection 2003, NRC 2009, Stein et al 2012). Increased runoff can also increase contaminant loads (Schueler and MWWRPB 1987, Grants et al 2003). Nevertheless, improving aquatic habitat for wildlife will generally tend to also improve water quality.

It should be noted than many of the indicators presented in Tables 3A-C could serve to asses either compliance or effectiveness. Many of the indicators for natural communities, species, and water quality (Tables 3A and 3B) can be used to assess individual habitat project performance. And, these same indicators can be applied across landscapes in probabilistic surveys to assess the overall effectiveness of the projects. The indicators of landscape condition (Table 3C) are most useful for assessing the cumulative effects of projects and other local management actions, relative to a preferred Landscape Profile, and therefore relate to the overall effectiveness of the Plan.

Landscape Scenario Planning

Existing environmental data and information for the landscape covered by the Plan support a simple demonstration of the concept of landscape scenario planning. The preferred Landscape Profile can only be surmised (see example Landscape Health Report Card below) because targets have not been established for many key conditions, including the spatial distribution, total abundance, patch size-frequency, inter- and intra-patch distance, and diversity of every priority habitat types. This section of the case study therefore formats existing and hypothetical data to illustrate the potential content of a landscape profile. It should be noted that the content of a profile will vary among landscapes depending on their nature and their management goals and objectives.

Planning Tools.

Although the focus of this case study is on monitoring and assessment, some of the emerging tools for large-scale wildlife conservation planning should be mentioned because they can be useful for landscape scenario planning.

- California Natural Diversity Database (CNDDB) (http://www.dfg.ca.gov/biogeodata/cnddb/). See Appendix 1 above.
- National Land Cover Database (NLCD 2011) http://www.mrlc.gov/index.php.[45] See Appendix 1 above.
- Marxan[46] http://www.uq.edu.au/marxan/index.html?page=80365. Marxan is software for designing large-scale wildlife conservation areas. It can be used to generate spatially explicit reserve systems in a GIS that achieve particular wildlife conservation objectives based on an economic and land use constraints. Marxan underpins an initiative involving a coalition of California state agencies to implement Regional Advanced Mitigation Planning (RAMP) for negative impacts to wildlife that are expected to result from large-scale, linear, infrastructure projects, including highways, railways, and levee systems (https://rampcalifornia.water.ca.gov/documents/18/dfe8a475-27cc-4985-8fce-5d42f2423ca6). Marxan has not been incorporated into HCP or NCCP.
- Areas of Conservation Emphasis (ACE-II) http://www.dfg.ca.gov/biogeodata/ace/ ACE-II has developed models to predict native species richness, rarity, and endemism for each of six taxonomic groups (birds, fish, amphibians, plants, mammals, and reptiles) and four habitat types (wetlands, riparian, rare upland natural communities, and high value salmonid habitat) across a statewide, 2.5 mi^2 hexagon grid. The models score each hexagon for indices of native species richness, rare species richness, "irreplaceability" (i.e., rarity-weighted richness), the presence of sensitive habitats, and overall biological richness. For each USDA ecoregion (http://www.fs.fed.us/rm/ecoregions/), the index scores for each hexagon are ranked 1-5, with the highest score indicating the richest or rarest flora and fauna. The interpretation of the indices is subject to certain assumptions and limitations explained in the ACE-II documentation; but areas with a high index score are expected to have high conservation value and meet multiple conservation goals (CDFG 2015).

  For this case study, the scores for the index of native species richness were acquired for each ACE-II hexagon within the area bounded by the Plan. Each hexagon was shaded by the rank of its score, with the darkest shade indicating the highest range of richness generated by the ACE-II models for the ecoregion (Figure 4).

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[45] Some regions of the state have their own land cover datasets that provide greater detail about more types of cover and greater spatial resolution the NLCD 2011. For example, NOAA maintains a separate map of coastal land cover as part of its Coastal Change Analysis Program (https://coast.noaa.gov/digitalcoast/tools/lca).

[46] Ball, IR and HP Possingham. 2009. MARXAN (V2.1.1): Marine Reserve Design Using Spatially Explicit Annealing, a Manual. University of Queensland, Brisbane, Australia. http://www.uq.edu.au/marxan/index.html?page=80365.

Figure 4: Expected native species richness for 2.5m^2 hexagons within the Plan area; data from ACE-II.

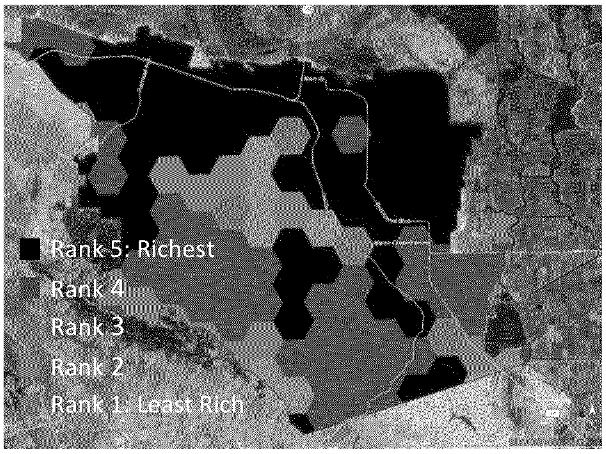


Figure 5: Historical habitats of the northern portion of the Plan area; from Stanford et al. 2011.

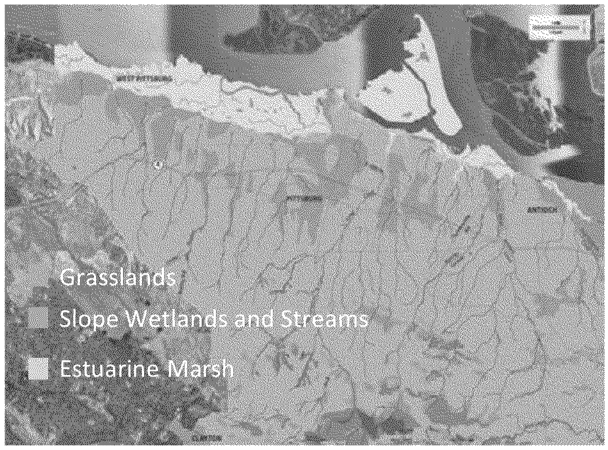


Figure 6: Distribution of major land covers in (Stanford et al. 2011) within the Plan area.

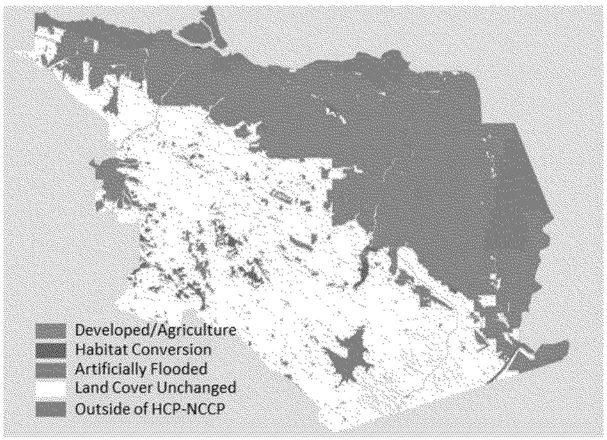
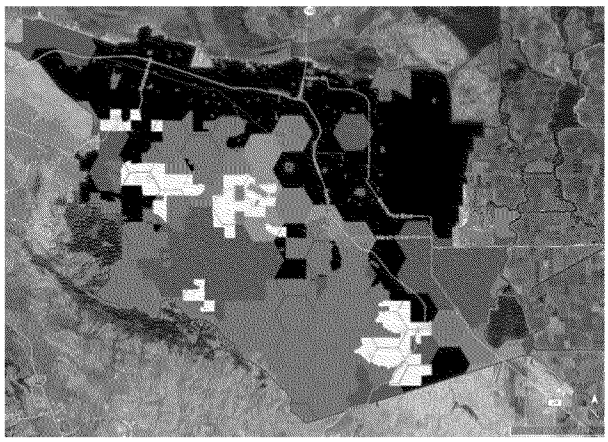


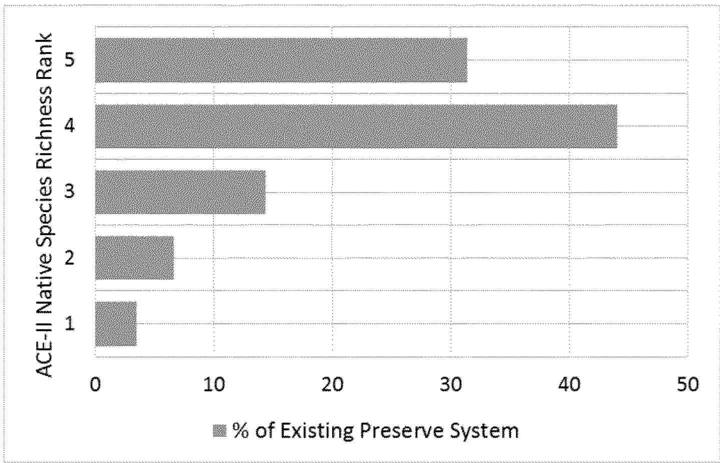
Figure 7: Preserve system and other protected areas in relation to ACE-II native species richness models within the Plan area.



The ACE-II indices can help guide conservation planning by indicating areas that might be considered for inclusion in habitat preserves and reserves. The indices are not intended to serve as the sole guidance, however. Habitat priorities, land use constraints, land availability and prices, and a variety of other factors must also be considered (Ball et al. 2009).

In this case, many of the rank-5 hexagons correspond to the broad historical ecotone between estuarine and upland ecosystems characterized by abundant streams terminating in slope wetlands (Figure 5). This same area is now largely urbanized (Figure 6). Undeveloped parcels in this urban area have been included in the reserve system of the Plan, which otherwise corresponds to hexagons in areas that are relatively unchanged and ranked medium to medium-high by the ACE-II models for native species richness (compare Figures 4 and 7). These data together allow a simple analysis of the distribution of reserve system acres among the ACE-II

Figure 8: Distribution of acres of the Preserve System of the Plan among ACE-II ranks for native species richness.



ranks for native species richness (Figure 8). Nearly 75% of the preserve system corresponds to areas ranked high to medium-high by the ACE-II models.

This analysis shows how new state tools can be used to help plan wildlife conservation actions and to assess their likely value to multiple wildlife species. As stated above, this is not the only analysis needed, but it suggests that some existing Level 1 datasets and tools might be under-utilized.

<u>*Abundance and Diversity of Habitat Types*</u>

CARI, RipZET, and WHR can be used to assess habitat abundance and diversity for any adequate base map. For this case study, CARI and WHR were applied to the area of the Plan to assess habitat abundance and diversity (Figures 9 and 10, and Table 4). RipZET was not applied to the Plan area, but data from other areas are used to demonstrate RipZET output (Figure 11). There is additional information provided by CARI that is not evident in these figures. For example, CARI indicates that the area of the Plan includes about 640 miles of streams. This is certainly an underestimate, given that much of CARI for this area is represented by NHD, which is less detailed than the area mapped using the CARI SOP (see Figure 3 and associated text above). A comparison between CARI and historical stream maps (Stanford et al. 2011) reveals that there has been little change in stream abundance and alignment above the urban and agricultural region of the Plan area, but within that region there has be extensive realignment, ditching, and the construction of artificial channels. The alluvial fans have been ditched, resulting in much less slope wetlands.

Figure 9: Historical proportions of habitat types and land covers (Stanford et al. 2011).

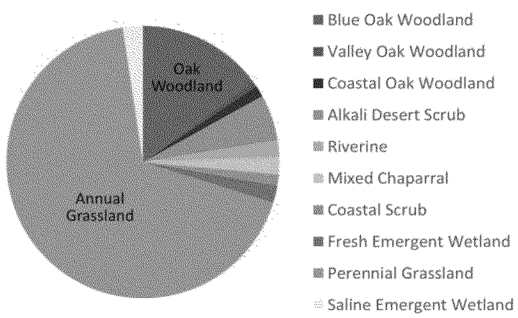


Figure 10: Existing proportions of habitat types and land covers based on CWHR and CARI.

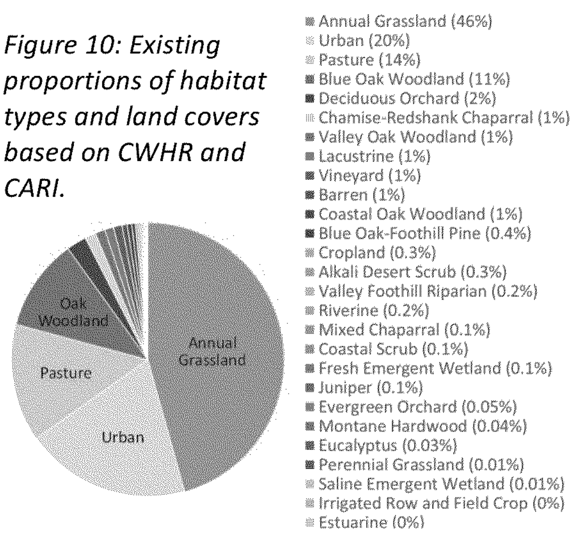


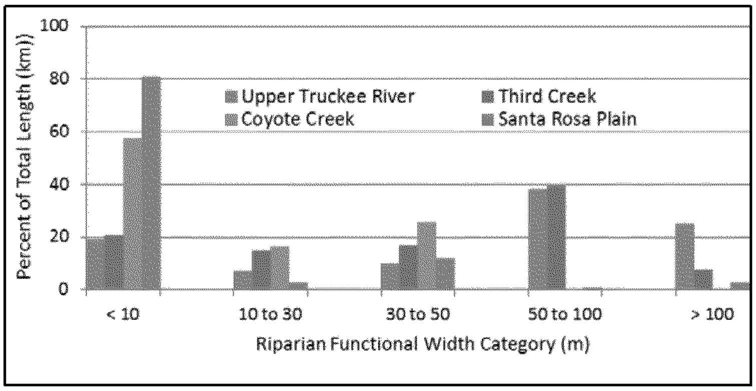
Table 4: Summary of the acres of habitat types preserved, restored, and/or permanently impacted based on the ECCC HCP Conservancy report (ECCCHC 2014), CARI, and CWHR.

Habitat Types	Total Acres within the ECCC HCP Area	Number of Acres		
		Preserved	Restored	Permanent Project Impacts
Aquatic Types (CARI)				
Stream Miles	643	64	0.6	0.3
Pond and associated vegetation	1,202	48	0.1	0.41
Slope and Seep Wetlands	6	0.8	0.01	0
Total Acres of Aquatic Habitat Types		112	0.7	0.7
Terrestrial Types* (CWHR)				
Annual Grassland	79,435	9,575	3	252
Blue Oak-Foothill Pine	738	24	0	0
Eucalyptus	45	4	0	0
Montane Hardwood	67	35	0	0
Blue Oak Woodland	18,944	2,382	0	1.0
Deciduous Orchard	4,126	0	0	1.0
Valley Oak Woodland	2,010	58	0	0.1
Valley Foothill Riparian	320	0	0	0.1
Urban	34,121	81	0	34
Vineyard	1,752	0	0	23
Pasture	24,210	0	0	8
Cropland	511	1	0	0.5
Chemise-Redshank Chaparral	2,286	131	0	0
Coastal Scrub	227	2	0	0
Barren	1,123	8	0	4
Alkali Desert Scrub	443	0	0	0.01
Total Acres of Terrestrial Habitat Types		12,302	18	324
* The acreage values for aquatic CWHR habitat types (riverine and ponds) were replaced with values from CARI.				

In general, the narrowest riparian widths relate to near-stream functions such as bank stability, shading, and runoff filtration. The intermediate widths relate to additional functions such as flood control, allochthonous input, and groundwater recharge. All riparian areas tend to provide some amount of wildlife support, but the widest areas are needed to provide the full suite ecological and other function (Collins et al. 2006).

RipZET was not applied to the Plan area because of limitations with the existing base map. To demonstrate the potential utility of RipZET for monitoring and assessing riparian resources in the Plan area, example data from four other areas are presented here (Figure 11).

Figure 11: Distribution of riparian areas among functional width classes for the Upper Truckee River (LRWQCB et al. 2014), Coyote Creek (EOA and SFEI 2011), and Santa Rosa Plain (Collins et al. 2014).



A cursory examination of aerial imagery for the Plan area plus recent descriptions of its riparian resources (Stanford et al. 2011) suggest it most closely resembles the Santa Rosa Plain in terms of the distribution of riparian areas among these width classes. A reasonable expectation is that the riparian ecosystem of the Plan area is characterized by relatively narrow riparian widths and therefore has very limited functional capacity. The Plan might therefore consider increasing riparian width where feasible.

The Plan is inconsistent with the emerging riparian definition recommended by the National Research Council (Brinson et al. 2002) being considered by the State Water Board (TAT 2009). It therefore is missing opportunities to employ RipZET, the tool developed to estimate riparian extent based on the proposed State Water Board definition (see Appendix 1). According to the definition, the number of riparian functions and the level of any given function tend to increase with riparian width (Collins et al 2006). RipZET estimates riparian extent for any set of functional width categories throughout user-defined landscapes. The total length of all riparian areas is summed for each category. The result is a measure of the absolute and relative abundance of riparian areas with different functional capacities. The results can inform efforts to identify deficits in riparian function, set target levels of function, determine the riparian widths that are needed to support selected functions, and assess the status and trends in riparian areas relative to the targets.

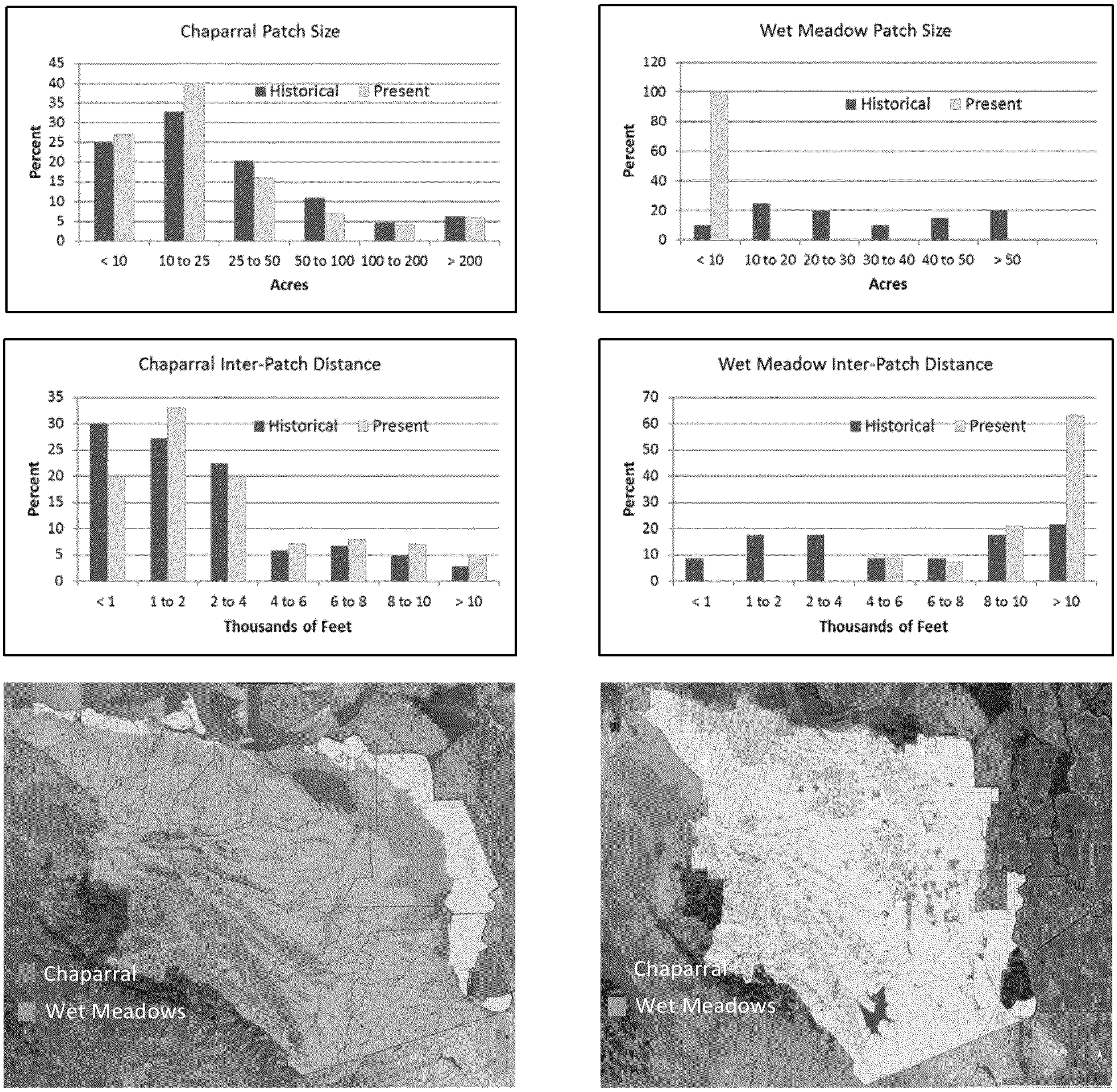
There is a need to standardize habitat classification, especially for aquatic habitat types. The Plan proffers a unique aquatic habitat classification system without a crosswalk to either CARI or NWI, which have a crosswalk to each other. This decouples the aquatic habitat mapping for the Plan from that being done elsewhere in the state. Measures of change in aquatic habitat abundance and diversity for the area of the Plan will therefore not be comparable to such measures elsewhere, and federal or state partnerships for mapping aquatic habitats will be difficult to develop. In contrast, the Plan employs a system for mapping and classifying vegetation that can be crosswalked to VegCAMP, and therefore can be translated into CWHR. This would bring the vegetation maps for the Plan into agreement with the statewide system for mapping and classifying terrestrial habitats.

<u>*Landscape Complexity*</u>

The primary assumption of this the report is that the capacity of a landscape to both conserve wildlife and improve water quality is related to its overall natural structural complexity. A variety of spatial metrics can be calculated from an adequate base map and selected overlaying data to assess this complexity (Forman and Godron 1981, Pickett and Cadenasso 1995). More specifically, for any given landscape, changes in habitat patch diversity, patch size-frequency, intra- and inter-patch distance, patch shape, extent of active floodplain, and riparian continuity can strongly influence the distribution and abundance of plants and animals (e.g., USFWS 1980, Taylor et al. 1993, Taylor et al. 2003, Fall et al. 2007, Lin 2008). While the functional ecological meaning of such metrics can vary among wildlife species (Kupfer 2012), their value in assessing the structural complexity of a landscape as a proxy for its resilience and overall ecological diversity is high (Carpenter and Brock 2004, Fischer et al. 2006, Carpenter 2013, USFS 2015).

For the area of the Plan, the utility of these metrics is limited by the known inadequacies of the base map and possible inadequacies of the habitat maps for some covered species. However, to demonstrate the potential value of these kinds of metrics for assessing the effectiveness of the Plan, a few basic metrics were estimated for the historical and present distributions of two key habitat types (Figure 12A-F).

Figure 12: Patch size-frequency for (A) chaparral and (B) wet meadows, and inter-patch distance-frequency for (C) chaparral and (D) wet meadows based on (D) the historical landscape (Stanford et al. 2011) and (E) the present landscape (CARI and CWHR).



This demonstration of selected landscape complexity metrics shows that patch size and inter-patch distance have changed little for chaparral, whereas wet meadows are both smaller and much farther apart. These findings are consistent with the analysis of historical change in total abundance of these habitat types (Stanford et al. 2011).

Summary of Landscape Scenario Planning

Ideally, landscape scenario planning involves using the WRAMP and wildlife conservation tools in a GIS to assess the effects of alternative wildlife conservation plans on fundamental spatial metrics of habitat abundance, habitat distribution, and landscape complexity. Having adequate maps of the key habitat types that can be modified and overlain onto an adequate base map to quantify the alternative plans is patently desirable. Having maps of historical conditions that are comparative to the maps of present conditions can be very helpful for setting target values of the metrics (i.e., defining the preferred landscape profile) but is not essential for landscape scenario planning.

The spatial metrics used in landscape scenario planning can also be used to monitor and asses the performance or effectiveness of conservation plans. That is, the metrics can be used to assess the status and trends of key habitat types relative to the preferred landscape profile.

Coordinated Monitoring and Assessment

As stated in the Plan:

> *"A well-coordinated and scaleable monitoring program design will enable the Implementing Entity and others to measure and evaluate change in resources and threats in individual preserves, across the entire Plan area, and within the ecoregion. Such coordination requires standardization of protocols, sampling design, and training of personnel, as well as integrative data analyses."*

To assist with coordination, the Plan identifies other wildlife conservation efforts occurring within or nearby area of the Plan.

- Los Vaqueros Watershed Management and Habitat Restoration (CCCWD).
- Management of East Bay Regional Park District units in the inventory area (EBRPD)
- Management of Mt. Diablo and Cowell Ranch State Parks (CDPR).
- Management of Byron Airport Habitat Management Lands by Contra Costa County.
- Restoration Program for Dutch Slough (California Coastal Conservancy, Natural Heritage Institute, and California Department of Water Resources).
- Marsh Creek Habitat Enhancement (City of Brentwood, City of Oakley, Natural Heritage Institute, CCCFCWCD).
- Marsh Creek Reservoir Expansion Project (CCCFCWCD).
- Mitchell Canyon Creek Restoration Project (Mt. Diablo State Park, Save Mount Diablo)
- Kirker Creek Watershed Management Plan (CCCRCD).

Most of these wildlife conservation efforts have an environmental monitoring component of their 404 and 401-WDR permits that includes water quality performance criteria and indicators. These efforts therefore provide an opportunity for the Plan to coordinate monitoring for water quality improvement as well as for wildlife conservation. In addition, the Plan should coordinate with other water quality monitoring efforts that are being conducted within or near to the ECCCHCP-NCCP. This coordination can be facilitated by the Central Valley and Bay Area Regional Water Quality Control Boards.

- Dutch Slough Tidal Marsh Restoration Project.
- San Francisco Bay Regional Monitoring Program for Water Quality.
- Delta Regional Monitoring Program for Water Quality.
- Delta San Francisco Bay Mercury TMDL Implementation monitoring.
- San Francisco Bay Mercury TMDL Implementation monitoring.
- All local water quality monitoring by the Contra Costa Clean Water Program.

The Plan does not clearly address the need to coordinate the various monitoring elements that the Plan recommends. The proposed framework can help guide the coordination. For example, as stated previously, Level 1 indicators should be prioritized over Level 2 indicators, which should be prioritized over Level 3 indicators. In other words, Level 3 indicators should not be employed if Level 1 or Level 2 indicators will suffice, and Level 2 indicators should not be employed if Level 1 indicators will suffice. This will increase the number of monitoring questions that are addressed using the same Level 1 or Level 2 indicators, and thus increase the opportunities to use the same, relatively inexpensive data to fulfill multiple monitoring requirements.

To state the obvious, every effort should be made to collect as many kinds of necessary data at the same monitoring sites and at the same time. For example, probabilistic surveys of habitat condition using Level 1-3 indicators can usually use the same monitoring sites. Tables 3A-C can be used to guide coordination of efforts to monitor the effects of Plan implementation on wildlife and water quality.

Condition of Species

Most species-specific monitoring and assessment is built into the compliance monitoring required to assess the performance of individual habitat projects (ECCCHC 2014). These monitoring results have not been compiled into a summary across the various projects. To date, there is no overall assessment of the effectiveness of the Plan for any covered species. The assessment of overall effectiveness of the Plan will depend on habitat and landscape metrics calculated for the Plan area as a whole, as demonstrated in the section above on landscape scenario planning. For the purpose of more directly assessing the performance of the Plan for individual species, probabilistic surveys of their presence should be considered, using maps of their effective habitats as sample frames (see Table 3A above).

Water Quality

In general, water quality monitoring is gradually shifting focus from water and sediment chemistry to indicators of the health of living resources as more direct measures of the beneficial uses of state and federal waters. Although the current water quality objectives mostly pertain to concentrations of contaminants in water, the use of biological and ecological indicators of water quality is increasing, and may lead to numerical objectives for habitat condition. The emphasis of the proposed framework on landscape profiles of aquatic resources is consistent with this trend.

The Bay Area Regional Water Quality Control Board (Regional Board) has identified urban runoff from local watersheds as a pathway for pollutants of concern into the Bay. Monitoring and assessment to address this concern is driven by the Regional Board's municipal regional stormwater permit (MRP).[47] The MRP contains several provisions requiring studies to measure local watershed loads of suspended sediment, total organic carbon, polychlorinated biphenyl (PCB), total mercury (Hg), total methylmercury (MeHg), nitrate-N (NO3), phosphate-P (PO4), total phosphorus, as well as other pollutants. Provision C.8.c of the MRP requires permittees to conduct creek status monitoring. In response, the Bay Area stormwater programs have collaborated with the San Francisco Bay Regional Monitoring Program (http://www.sfei.org/rmp) to develop the Small Tributaries Loading Strategy (STLS). The purpose of the STLS is to address the following four key management questions. The last question highlights the need to coordinate water quality control actions with wildlife conservation actions to assure their positive synergies.

- Which Bay tributaries contribute most to Bay impairment from POCs?
- What are the annual loads or concentrations of POCs from tributaries to the Bay?
- What are the decadal-scale loading or concentration trends of POCs from small tributaries to the Bay?
- What are the projected impacts of management actions on tributaries and where should these management actions be implemented to have the greatest beneficial impact?

These actions must also protect the beneficial uses of the streams, as identified in the Regional Boards' Basin Plans. The beneficial uses for Marsh Creek reflect its importance for aquatic wildlife (Table 5).

The single best source of water quality data for the area of the Plan is the annual report of the Contra Costa Clean Water Program (http://www.cccleanwater.org/). Marsh Creek is one focal area of the report due to its known importance as a source of multiple contaminants of concern.

The creek status monitoring design for each stormwater program is described in MRP. The regional strategy for complying with MRP Provision C.8.c is described in the Regional Monitoring Coalition Final Creek Status and Long-Term Trends Monitoring Plan (BASMAA, 2012). The strategy includes a regional probabilistic monitoring component to assess ambient condition and another component based on local "targeted" monitoring. The combination of these monitoring components allows each individual participating stormwater management program to assess the status of beneficial uses in local creeks within its jurisdictional area, while also contributing data to answer management questions at the regional scale.

Marsh Creek watershed has been identified as a potentially important source of mercury (http://sacriver.org/files/201305_3_MtDiablo.pdf). An abandoned mercury mine is located on Dunn Creek, a tributary to Marsh Creek in its upper watershed. Runoff from the historic mercury mine tailings in the upper reaches of Marsh Creek has resulted in high concentrations of MeHg in the upper watershed, but the Marsh Creek reservoir evidently traps a significant amount of sediment, and presumably mercury, from the mine tailings site (Slotton et al. 1998).

[47] http://www.waterboards.ca.gov/rwqcb2/water_issues/programs/stormwater/Municipal/index.shtml.

Table 5: Beneficial Uses for Marsh Creek, as defined by the State Water Board.[48]

RARE	*Uses of waters that support habitats necessary for the survival and successful maintenance of plant or animal species established under state and/or federal law as rare, threatened, or endangered.*
REC1	*Uses of water for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and uses of natural hot springs.*
REC2	*Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where water ingestion is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.*
WARM	*Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.*
WILD	*Uses of waters that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.*

The following findings are summarized from the annual report of Contra Costa Clean Water Program for water years 2012-2014 (CCCWP 2014).

- Significant reductions in the survival of the amphipod *Hyalella azteca* was observed during both WY 2012 storm events. Water Year 2013 had complete mortality of *Hyalella Azteca* between 5 and 10 days of exposure to stormwater during all four storm events. Additionally, one sample from Water Year 2013 caused a significant reduction in fathead minnow survival. No significant effects were observed for the crustacean *Ceriodaphnia dubia* or the algae *Selenastrum capricornutum* during these storms.
- The maximum PCB concentration (4.32 ng/L) was similar to background concentrations normally found in relatively nonurban areas.
- The maximum Hg concentrations (252 ng/L) were similar to concentrations found in mixed land use watersheds.
- Maximum MeHg concentrations (0.407 ng/L during WY 2012 and 1.2 ng/L during WY 2013) were greater than the proposed implementation goal of 0.06 ng/l for methylmercury in ambient water for watersheds draining to Central Delta. Nutrient concentrations appear to be reasonably typical of other Bay Area watersheds.

[48] The State Water Board recognizes that many individual wetlands provide multiple benefits depending on the wetland type and location Wildlife Habitat (WILD); Preservation of Rare and Endangered Species (RARE); Shellfish Harvesting (SHELL); Water Contact Recreation (REC1); Noncontact Water Recreation (REC2); Commercial, and Sport Fishing (COMM); Marine Habitat (MAR); Fish Migration (MIGR); Fish Spawning (SPAWN); and Estuarine Habitat (EST). Some of these general beneficial uses can be further described in terms of their component wetland function. For example, many wetlands that provide groundwater recharge (GWR) also provide flood control, pollution control, erosion control, and stream base flow.

- Phosphorus concentrations were high but consistent with findings for other Bay Area watersheds, perhaps due to abundant geological sources.

Based on the reports of the CCCWP, the water quality status for Marsh Creek relative to existing water quality objectives and criteria are summarized below (Table 6). These water quality metrics can be combined with the landscape and habitat metrics discussed above to produce a robust report on landscape condition that integrates across wildlife conservation and water quality improvement (see example Landscape Health Report Card below).

Table 6. Comparison of key water quality metrics to numeric and narrative objectives as reported in the 2014 annual monitoring of the Contra Costa Clean Water Program in the Marsh Creek Watershed (CCCWP 2014).

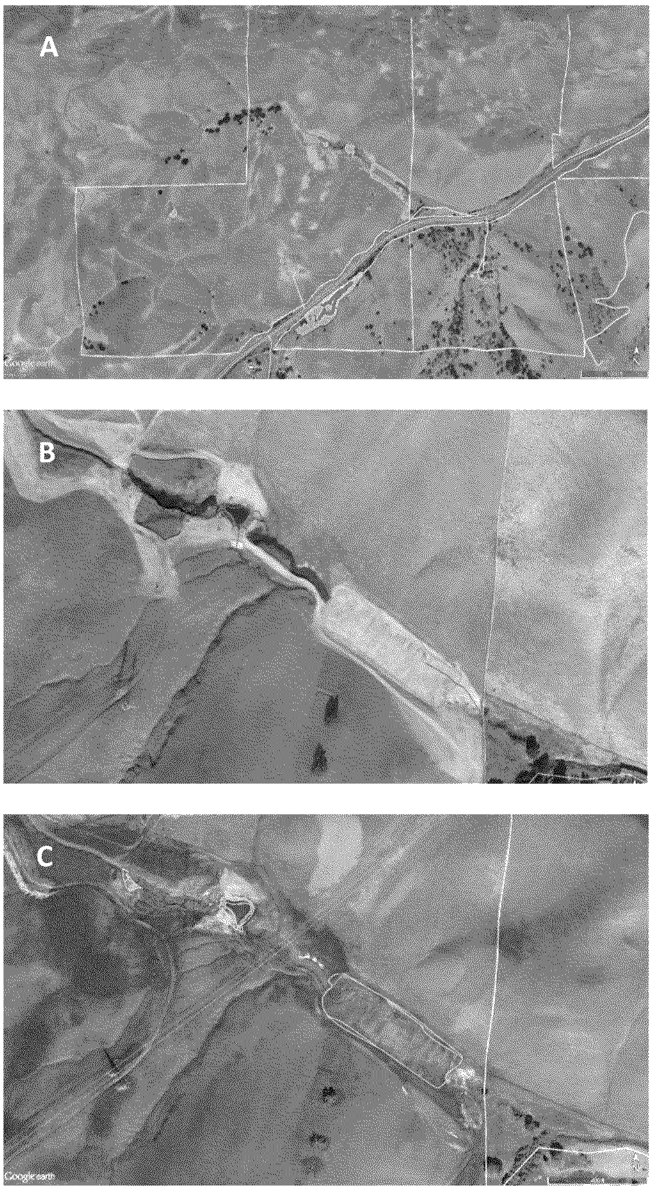
<table>
<tr><th>Location</th><th>Year</th><th>Analyte</th><th>Numeric Water Quality Objective/ Criterion (µg/L)</th><th># of Samples > Objective/Criterion</th></tr>
<tr><td rowspan="6">Lower Marsh Creek</td><td>2012</td><td>Copper</td><td>13</td><td>0/2</td></tr>
<tr><td>2012</td><td>Selenium</td><td>20</td><td>0/2</td></tr>
<tr><td>2012</td><td>Mercury[49]</td><td>2.1</td><td>0/8</td></tr>
<tr><td>2013</td><td>Copper</td><td>13</td><td>0/4</td></tr>
<tr><td>2013</td><td>Selenium</td><td>20</td><td>0/4</td></tr>
<tr><td>2013</td><td>Mercury</td><td>2.1</td><td>0/17</td></tr>
<tr><th>Location</th><th>Year</th><th colspan="2">Event / Media</th><th>Observations</th></tr>
<tr><td rowspan="3">Dry Creek</td><td>2012</td><td colspan="2">Wet Weather Water Toxicity</td><td>Significant reductions in survival of Hyalella azteca</td></tr>
<tr><td rowspan="2">2012</td><td colspan="2">Dry Weather Sediment Toxicity</td><td>Significant reductions in survival of Hyalella azteca</td></tr>
<tr><td colspan="2">Dry Weather Sediment Chemistry</td><td>Highest concentration of contaminants of all Creek Status stations in Region</td></tr>
<tr><td>Marsh Creek</td><td>2012</td><td colspan="2">Benthic Index of Biological Integrity</td><td>Very Low Score</td></tr>
</table>

[49] While the measures of mercury concentration did not exceed the objective for the creek, it exceeded the proposed objective for the Delta as a receiving water body for Marsh Creek discharge.

Project Tracking

Accurate maps of habitat projects are essential to track the project performance and progress toward the acreage goals of the Plan. These are major aspects of compliance monitoring. Accurate mapping is also important to assess the cumulative effects of projects on the overall distribution, abundance, and diversity of habitat types. This is an important aspect of effectiveness monitoring.

Figure 13. Map of Kirker Creek restoration project overlain on NAIP imagery of different vintage to show (A) the Preserved Area (outlined in white), component sites (yellow), target stream reaches (blue), and impact areas (red) at the time of construction; (B) project 2 months post construction; and (C) project 2.5 years post construction. Source of project map is the ECCCHC.



The landscape metrics discussed above (see section titled *Landscape Scenario Planning*) can detect any measured change in habitat distribution, abundance, diversity, and connectivity. The accuracy of these metrics depends on the accuracy of the habitat maps. Ideally, all the habitat maps, including the maps of restoration and mitigation projects, would have comparable accuracy and sufficient detail to assess spatial changes in habitats in terms of their effects on wildlife and water quality.

In general, for the purpose of ecological assessments, less accuracy is required to adequately map patches of habitat for cover species that are very motile and have large home ranges, such as the Golden Eagle or Swainson's Hawk, than for less motile species with smaller home ranges, such as the California Tiger Salamander and Red-legged Frog. However, the level of map accuracy should be standardized based on the highest level needed to accurately assess habitat change for any covered species.

Project mapping for aquatic habitats should depict each component site and habitat type within each project, based on a standard statewide classification system, such as CARI. This is essential to assess ecological connectivity within and among projects. For example, some streams will have multiple restoration projects that together effect riparian continuity. Some depressional wetland projects will involve multiple wetlands that together affect the habitat value of any one wetland.

The project mapping to-date seems accurate enough to assess compliance with acreage goals, while also helping to assess the larger-scale effectiveness of the Plan for conserving the covered animals (Figure 13). With regard to effectiveness monitoring, it should be possible to combine the project maps with the overall inventories of habitat types to create a meaningful sample frame for probabilistic surveys using Lever 1-3 tools. For example, many of the short-term and longer-term changes in habitat condition within and around projects, as evidenced in NAIP imagery (see Figure 13), will be detected by the landscape metrics and by CRAM. Mapping patches of the covered plants with the same level of accuracy required for mapping and assessing animal habitats will involve more field work, but is certainly possible using modern technologies.

The Plan uses a unique database capable of tracking acres of impacts and acres of projects as well as other monitoring information. A custom program has been developed by the ECCCHC to query the project tracking database and the HCP-NCCP database to generate information for annual monitoring reports. Despite the ECCCHC's investment in its custom project tracking system, it should consider the benefits of using an existing tracking system gaining federal and state support. The benefits to consider include, but are not limited to the following.

<u>*Cost sharing.*</u>

The cost for operating and maintaining a statewide or regional system for mapping and tracking projects can be distributed across its user community. This can substantially reduce costs for any given user.

<u>*Statewide consistency.*</u>

By using a statewide or regional system that employs statewide standards, the data for any given project can be compiled with data from other projects to more comprehensively assess the contribution of each and every project to regional and statewide conditions. This can be helpful for garnering regional, state, and federal support for local project tracking.

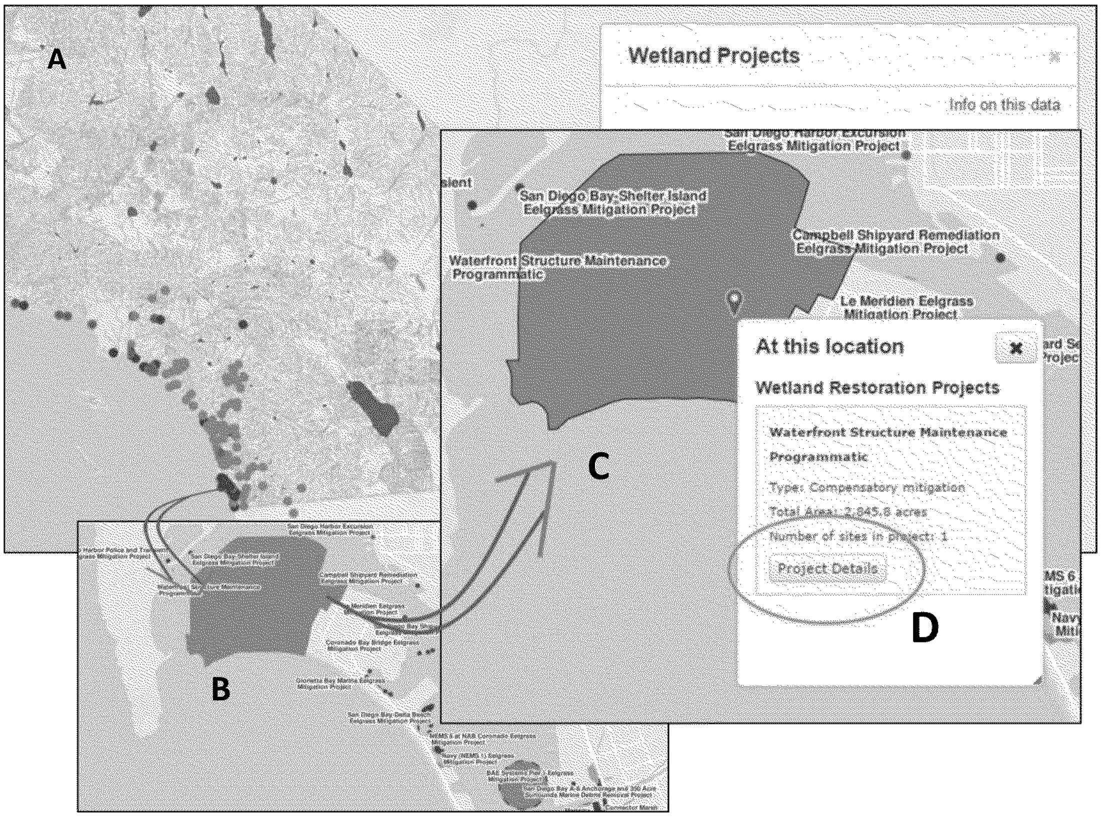
<u>*Communication.*</u>

There are project mapping systems available that make finalized habitat maps, project maps and related information available to the public in ways that can greatly enhance public awareness and inter-agency coordination. Furthermore, the available systems can greatly improve data sharing among habitat conservation plans and facilitate their contribution to regional and statewide understanding of habitat conditions.

The readily available systems that the ECCCHC might consider adopting are the Project Tracker of EcoAtlas and the HabiTrak of the San Diego Country HCP-NCCP. Of these two systems, the Project Tracker might be the most beneficial at this time. The Project Tracker system (Figure 14) is described briefly in Appendix 1, and the HabiTrak is described in Appendix 2. Some functions of the Project Tracker that distinguish it from HabiTrak and that are not covered in Appendix 1 are listed below. In brief, the Project Tracker:

- Operates on CARI as the statewide base map that can be edited online by registered editors;
- Enables heads-up, online, remote mapping at any scale on NAIP imagery or imported imagery;
- Turns every project polygon into a repository for information of any kind, including flat files of tabular data, photographs, videos, and URLs, with a searchable database;
- Provides instant toggling between the project database and the on-screen map of projects;
- Enables project maps to be automatically incorporated into the Landscape Profile Tool for summaries of project acreages by habitat type for any user-defined landscape; and
- Provides password protected if necessary.

Figure 14. Composite screenshot of Project Tracker capacity and functionality showing (A) CARI base map; (B) online zooming to a selected project; (C) further zooming to reveal local project context (base map can be instantly replaced with for NAIP imagery, USGS topographic quadrangle, or custom map or imagery); and (C) drop-down summary of basic project information with a clickable link to the project data base for more information.



Data Management

As stated above, the Plan uses a unique database capable of tracking acres of impacts and acres of projects as well as other monitoring information. However, the Plan can benefit from either incorporating functionality provided by other data management systems or adopting one of them into the Plan's system. Of the available systems supported by state and federal agencies, the Project Tracker of EcoAtlas probably provides the most benefits. It should be noted that the use of Project Tracker is being encouraged through the 404 Program of USACE and USEPA, the 401-WDR Program of the State Water Board and the Bay Area Regional Water Board, the State Coastal Conservancy, the Delta Conservancy, and the Central Valley and Bay Area Habitat Joint Ventures. The USACE and USEPA are also encouraging the further development and use of the Landscape Profile Tool to help implement the landscape approach to mitigation planning through the 404 Program. Both of these WRAMP tools depend on EcoAtlas to assemble input data. EcoAtlas is briefly described in Appendix 1. Additional information about EcoAtlas is outlined below with regard to data management.

EcoAtlas Web Services

EcoAtlas aggregates and displays a variety of information relevant to managing and regulating aquatic resources. It does not have its own database, but instead uses web services[50]to access and retrieve data and information that are summarized and displayed by the Landscape Profile Tool and Project Tracker. For example, EcoAtlas uses a web service to request watershed maps for any user-selected stream in CARI from the StreamStats Program of the USGS (http://water.usgs.gov/osw/streamstats/). It also uses web services to retrieve data from the CNDDB of BIOS, water quality data from CEDEN, and US Census data from the US Census Bureau. Likewise, other online data management systems can use web services to access data from EcoAtlas. For example, services are being planned to exchange data between EcoAtlas and NWI of the USFWS, and between EcoAtlas and the Lake Tahoe Environmental Improvement Program (EIP) of the Tahoe Regional Planning Agency (TRPA) http://www.trpa.org/about-trpa/how-we-operate/environmental-improvement-program/).

EcoAtlas could also use web services to access and retrieve project maps and related information developed for the Plan. To be more specific, if the ECCCHC decided not to adopt Project Tracker of WRAMP as the preferred system for mapping and tracking projects, it might still use web services to enable Project Tracker to access the Plan's databases as needed to publically display the project maps and information, and to enable the Landscape Profile tool to incorporate the projects into the automated landscape profiles. This would at least realize some of the possible benefits of Project Tracker (see bulleted list of benefits above).

To the full degree appropriate, the Plan should utilize the best available data management and delivery systems developed through state and federal agencies for coordinating aquatic resource protection and restoration in California.

Reporting

According to the WRAMPw framework, reporting involves the synthesis and formatting of aquatic resource information to answer monitoring questions and hence address driving concerns about aquatic resource protection. The Landscape Profile Tool and Landscape Health Report Card are two tools that might especially benefit annual reporting for the Plan. It should be noted that the Health Report Card is more of a concept than a tool at this juncture, although is it has served as the framework for the State of the Estuary Report, and is being considered by some local agencies as the framework for reporting local watershed conditions (see Appendix 3). At this time, the Landscape Profile Tool has more proven utility.

Landscape Profile Tool

The landscape Profile Tool is briefly described in Appendix 1. In the conjunction with Project Tracker, or through web services (see web services discussion immediately above), the Landscape Profile Tool could be adapted to generate the required annual reports on acres of impacts, restoration, and compensatory mitigation. It could also serve to summarize and report any L1-3 monitoring data into a Landscape Health Report Card (Appendix 3 and Figure 15). The existing Landscape Profile Tool cannot provide these services at this time, but its design and existing functions could be adapted to provide these services at much less cost than developing a new tool.

[50] Web Services Glossary, World Wide Web Consortium (https://www.w3.org/TR/2004/NOTE-ws-gloss-20040211/#webservice).

Example Landscape Health Report Card

The following diagram (Figure 15) illustrates the concept of a Landscape Health Report Card summarizing conditions for wildlife and water quality, based on the template provided in Appendix 3. Values for selected metrics 1-50 were gleaned from recent annual reports of the ECCCHC (ECCCHC 2014) and CCCWP (CCCWP 2014). Not all the data provided in these monitoring reports were used in this example, which is meant to be illustrative and not comprehensive. A Landscape Health Report Card will not meet all reporting needs of an HCP, NCCP, 404 Permit, 401 Certification, or other environmental regulatory permits for any given landscape. Each permit has monitoring and reporting requirements that cannot be met by a single overarching report. However, an integrated Landscape Health Report with a Health Report Card can serve to communicate environmental status and trends across policies and programs for entire landscapes.

Figure 15: Example Landscape Health Report Card. Health status for any given metric equals 100 minus the plotted metric value. For example, the health status for metric 1 is 100 - 41 = 59. Health status for any given group of metrics equals the sum total of their metric values divided by the number of metrics. For example, the health status for metrics 1-5 is 300/5 = 60. This means that the health status for all the aspects of health represented by these five metrics s 60% of good health. Example health scores for meaningful groups of metrics are presented in parentheses. Table 7 on the next page serves as the legend for this figure.

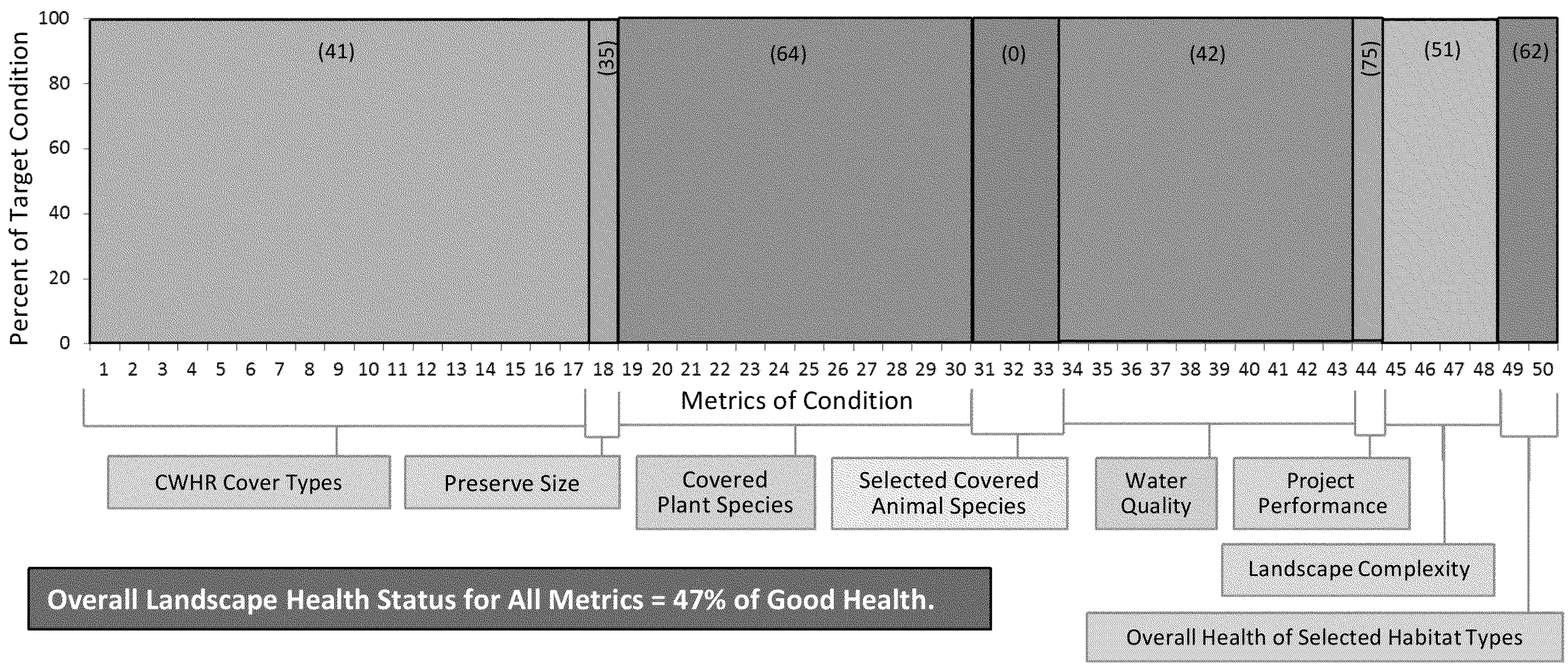


Table 7: Description of metrics plotted in Figure 15.

#	Name	Target Condition
1	% of Target Acres of All Grassland and Irrigated agriculture	Preserve Area should have at least 1,815 acres
2	% of Target Acres of All Chaparral and Scrub	Preserve Area should have at least 550 acres
3	% of Target Acres of All Oak Savanna	Preserve Area should have at least 500 acres
4	% of Target Acres of All Oak Woodland	Preserve Area should have at least 400 acres
5	% of Target Acres of All Riparian Woodland and Scrub	Preserve Area should have at least 70 acres
6	% of Target Acres of All Freshwater Perennial Wetland	Preserve Area should have at least 75 acres
7	% of Target Acres of All Seasonal Wetland Except Vernal Pools	Preserve Area should have at least
8	% of Target Acres of All l Alkali Wetland	Preserve Area should have at least 93 acres
9	% of Target Acres of All Ponds	Preserve Area should have at least 16 acres
10	% of Target Acres of All Reservoir(open water)	Preserve Area should have at least 12 acres
11	% of Target Acres of All Tidal Sloughs and Channels	Preserve Area should have at least 36 acres
12	% of Target Acres of All Perennial Non-tidal Stream	Preserve Area should have at least 4,224 acres
13	% of Target Acres of All Intermittent Stream	Preserve Area should have at least 2,112 acres
14	% of Target Acres of All Ephemeral or Unclassified Stream	Preserve Area should have at least 26,400 acres
15	% of Target Acres of Seeps and Springs	Preserve Area should have no permanent loss of any seep or spring
16	% of Target Acres of Wet Meadows	Preserve Area should have no permanent loss of any wet meadow habitat
17	% of Target Acres of Estuarine Wetland	Preserve Area should have at least 6.0 acres of estuarine wetland
18	Acres of the ECCC-HCP Habitat Preserve	30,300 acres preserved in 30 years
19	Occurrence of Mount Diablo manzanita	2 occurrences protected by the Plan
20	Occurrence of Brittlescale	2 occurrences protected by the Plan
21	Occurrence of San Joaquin spearscale	0 occurrences protected by the Plan
22	Occurrence of Big tarplant	3 occurrences protected by the Plan
23	Occurrence of Mount Diablo fairy lantern	1 occurrences protected by the Plan
24	Occurrence of Recurved larkspur	2 occurrences protected by the Plan
25	Occurrence of Round-leaved *filaree*	2 occurrences protected by the Plan
26	Occurrence of Diablo *helianthella*	2 occurrences protected by the Plan
27	Occurrence of Brewer’s dwarf flax	1 occurrences protected by the Plan
28	Occurrence of Showy *madia*	0 occurrences protected by the Plan
29	Occurrence of Adobe *navarretia*4	1 occurrences protected by the Plan
30	Occurrence of Shining *navarretia*	1 occurrences protected by the Plan

Table 7 (Continued): Description of metrics plotted in Figure 15.

#	Name	Target Condition
31	Covered Amphibians	At least 7 of thirteen 13 ponds support California Tiger Salamander, Western Pond Turtle, or California Red-Legged Frog
32	Annual Grassland/Suitable foraging habitat for Swainson's hawk	At least 1,000 acres.
33	Vernal Pool Occupancy	All pools restored or created for covered invertebrates are occupied by them
34	2012 Lower Marsh Creek Copper, Number of Cases Exceeding Numeric Objective	All cases < 13 (μg/L) in creek water
35	2012 Lower Marsh Creek Copper Selenium, Number of Cases Exceeding Numeric Objective	All cases < 20 (μg/L) in creek water
36	2012 Lower Marsh Creek Mercury, Number of Cases Exceeding Numeric Objective	All cases < 2.1 (μg/L) in creek water
37	2013 Lower Marsh Creek Copper, Number of Cases Exceeding Numeric Objective	All cases <13 (μg/L) in creek water
38	2013 Lower Marsh Creek Selenium, Number of Cases Exceeding Numeric Objective	All cases <20 (μg/L) in creek water
39	2013 Lower Marsh Creek Mercury, Number of Cases Exceeding Numeric Objective	All cases < 2.1 (μg/L) in creek water
40	2012 Dry Creek Wet Weather Water Toxicity	No significant reductions in survival of *Hyalella azteca*
41	2012 Dry Creek Dry Weather Sediment Toxicity	No significant reductions in survival of *Hyalella azteca*
42	2012 Dry Creek Dry Weather Sediment Chemistry	Low concentration of contaminants relative to regional Creek Status monitoring stations
43	2012 Marsh Creek Benthic Index of Biological Integrity	High average BMIBI score for watershed
44[51]	Project Performance	All projects meet there scheduled performance criteria to-date
45[51]	Chaparral Patch Size	Distribution of patches among size classes matches historical conditions
46[51]	Chaparral Patch Distance	Distribution of patches among distance classes matches historical conditions
47[51]	Wet Meadow Patch Size	Distribution of patches among size classes matches pre-European contact conditions
48[51]	Wet Meadow Patch Distance	Distribution of patches among distance classes matches historical conditions
49[51]	Riparian Functional Width	Distribution of patches among distance classes matches historical conditions
50[51]	Total Length of Riparian Forest	Total length of riparian forest matches historical conditions

[51] Target conditions for landscape metrics 44-50 are based on historical data and are not included in the Plan.

Citations for Appendix 4

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